SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1915.

CONTENTS.

GENERAL PHYSICS.

PAGE
1486. Comparators for the Indian Government **585**
1487. Molecular Homology as shown by Properties of Metals. *P. Ludwik* **585**
1488. Similitude and Dimensions. *R. C. Tolman* **586**
1489. Cohesion of Solids. *H. Chatley* **586**
1490. Deficit and Excess of Gravity upon Continents and Islands. *E. Belot* **587**
1491. Number of Molecules in the Surface between a Liquid and Vapour. *C. A. Mebius* **588**
1492–1493. .... **588**
1494. Meteorological Conditions in Netherlands and Circumjacent Places. *J. P. van der Stok* **588**
1495. Meteorological Conditions in Netherlands and Circumjacent Places. *J. P. van der Stok* **589**
1496. Volcanic Dust Veils and Climatic Variations. *H. Arctowski* **589**
1497. Construction of the Heavens. *F. W. Dyson* **589**
1498. Distribution of Solar Activity Areas. *A. A. Buss* **591**
1499. Photographs of Solar Eclipse, 1914 August 21. *C. Benedicks & I. Fredholm* **591**
1500. Internal Structure of Earth and Moon. *H. Jeffreys* **591**
1501. Perturbations of the Satellite of Neptune. *G. Armellini* **591**
1502. Capture Theory of Satellites. *T. J. J. See* **592**
1503. Variation of Latitude. *E. Przybyllok, B. Wanach* **592**
1504. Eclipsing Binaries. *H. Shapley* **592**
1505. Density of Molecules in Interstellar Space. *L. V. King* **592**
1506. Radial Velocities of 500 Stars. *W. S. Adams* **593**
1507. Eclipsing Variable δ Orionis. *J. Stebbins* **593**
1508. Light Curve of XX Cygni. *H. Shapley & M. B. Shapley* **593**
1509. Proper Motions of Stars near ω Centauri. *R. T. A. Innes & J. Voûte* ... **594**
1510. Olbers' Method of calculating Parabolic Orbits. *T. Banachiewicz* **594**
1511. Stellar Proper Motions by Stereoscopic Photography. *J. C. Solà* **594**
1512. Stellar Proper Motions by Stereoscopic Photography. *M. Wolf* **594**

PAGE
1513. Stellar Classification. *N. Lockyer* 594
1514. Effective Wave-lengths of Stars in Cluster N.G.C. 1647. *E. Hertzsprung* 594
1515. Effective Wave-lengths of absolutely Faint Stars. *E. Hertzsprung* 595
1516. Colour-indices in Cluster N.G.C. 1647. *F. H. Seares* 595
1517. Short-period Variable Stars. *G. Hornig* 595
1518. Absolute Scale of Photographic Magnitudes. *F. H. Seares* 596
1519. Absolute Motion of Parallax-stars. *K. W. Gyllenberg* 596
1520. R Corona Borealis. *A. A. Nijland* 596

LIGHT.

1521. Stereo-radioscopy. *Gibon* 597
1522. Use of Compensators in Displacement Interferometry. *C. Barus* 597
1523. Fresnel's Coefficient. II. *P. Zeeman* 597
1524. Diffraction Grating. *A. Gullstrand* 597
1525. Retarding produced by addition of Sugar to Metol-Hydroquinone. *T. Maldiney* 598
1526. Polarisation by Gratings in Visible Spectrum. *C. Bergholm* 598
1527. Infra-red Arc Spectrum of Barium. *H. M. Randall* 598
1528. Thiele's "Phase" in Band Spectra. *H. S. Uhler* 598
1529. Simultaneous Action of Electric and Magnetic Fields. *A. Garbasso* 599
1530. 599
1531. Emission Spectra of the Common Gases. *F. Croze* 599
1532. Fluorescence and Resonance of Sodium Vapour. II. *R. J. Strutt* 599
1533. Fluorescence of Frozen Solutions of Uranyl Salts. *H. L. Howes* 599
1534. Diamond constructed with Theoretical Carbon Atoms. *A. C. Crehore* ... 600
1535. Röntgen-ray Spectra. *M. Siegbahn* 600
1536. Experiments on Radio-active Emanations. *A. Debierne* 600
1537. Atomic Weight of Radio-active Emanations. *A. Debierne* 601
1538. Distribution of Radio-elements in Rocks. *M. Bultuch & G. Weissenberger* 601
1539. Radio-activity of Spring Water. *R. R. Ramsey* 602
1540. Volatisation of Thin Radio-active Deposits. *A. B. Wood* 602
1541. Radium Emanation in the Atmosphere. *J. R. Wright & C. F. Smith* ... 603

HEAT.

1542. Coefficient of Expansion of Solids. *S. Valentiner & J. Wallot* 604
1543. The Mercury-resistance Thermometer. *W. Jaeger & H. v. Steinwehr* ... 604
1544. Specific Heat of Steam at Atmospheric Pressure. *J. H. Brinkworth* 604
1545. Accuracy of the Bomb Calorimeter. *E. J. Dittus* 605
1546. Vapour Pressures of Halogen Hydrides. *O. Maass & D. McIntosh* 605
1547–1548. 605

ELECTRICITY AND MAGNETISM.

1549–1551. 606
1552. Energy of a Moving Electron. *L. Page* 606
1553. Experiments on Ionised Gases. *E. Salles* 607
1554. Charged Surface Layers on Electrodes. *K. T. Compton & L. W. Ross* ... 607
1555. Control of Electric Spark Discharge. *W. O. Sawtelle* 607
1556. Electric Conductivity of Pure Liquids. *J. Carvallo* 608

PAGE
1557. Dielectric Constants of Gases. *L. Verain* 608
1558. Influence of Weight of Hammerhead on Interrupter. *W. B. v. Czudnochowski* 609
1559. A.C. Resistance of Short Coils. *C. W. Oseen* 609
1560. Thermoelectric Power and Mechanical Strain. *W. P. White* 609
1561. Alternating-current Bridge. *D. Owen* 610
1562. Ballistic Galvanometer on prolonged Discharges. *A. G. Worthing* 610
1563. The Electrodynamometer. *A. Barbagelata* 611
1564. The Kathode-ray Tube and its Application. *M. E. Tressler* 611
1565. Induction Balance for determining Presence of Shells in Land. *C. Gutton* 611
1566. Magnetic Habits of Alloy Steels. *J. A. Mathews* 612
1567. Magnetic State of a Twisted Iron Bar. *G. J. Elias* 612
1568. Magnetisability of Oxides of Mn, Cr, and W. *E. Wedekind & C. Horst* ... 613
1569. Magnetic Susceptibility of Nickel Salts. *P. Weiss & E. D. Bruins* 613
1570. Magneto-chemical Researches on Ferrous Salts. *P. Weiss & C. A. Frankamp* 614
1571. "H" determined by Discharge from Wehnelt Kathode. *C. T. Knipp & L. A. Welo* 614
1572. Theories regarding Magnetism. *R. Jouaust* 614
1573. 614
1574. Magnetic Observations during Solar Eclipse. *C. Chree* 615
1575. Secular Change in the British Isles. *C. Chree* 615
1576. Localisation of Projectiles by Radiography. *A. Gascard & E. Beignot-Devalmont* 615
1577. Electro-vibrator worked with Interrupted Currents. *E. F. Perreau* 615

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1578. Experiments on the Production of Helium. *A. Debierne* 616
1579. Gases produced by Radio-active Substances. *A. Debierne* 616
1580. Properties of Elements and the Periodic System. *N. Dhar* 616
1581. Conductivity of Air in Contact with Phosphorus. *R. Schenck & E. Breuning* 617
1582. Chemical Action of Discharges through Gases. *E. Briner, J. Kahn* 617
1583. Cerium-Magnesium Alloys. *R. Vogel* 618
1584. Thermochemistry of Compounds of Cn and Al. *L. Rolla* 618
1585. Properties of Thallium-Lead Alloys. *L. Rolla* 619
1586. Behaviour of Vanadium and of Boron towards Silicon. *H. Giebelhausen* 620
1587. Properties of Cold-worked Metals. *T. M. Lowry & R. G. Parker* 620
1588. Steel before and after Heat Treatment. *R. R. Abbott* 621
1589. Fatigue of Copper Alloys. *E. Jonson* 621
1590. The Weston Normal Cell. *H. v. Steinwehr* 622
1591. Electrolytic Diaphragm Phenomena. *A. Bethe & T. Tropoff* 622
1592. Electrochemistry of Polonium. *G. v. Hevesy & F. Paneth* 623
1593. Electroplating with Cobalt. *H. T. Kalmus, C. H. Harper, & W. L. Savell* 623
1594. Anodic Potentials of Silver. *J. H. Reedy* 624

AUTHORS' INDEX.

Abbott, R. R., 1588.
Adams, W. S., 1506.
Arctowski, H., 1496.
Armellini, G., 1501.
Baltuch, M., 1538.
Banachiewicz, T., 1510.
Barbàgelata, A., 1563.
Barus, C., 1522.
Beignot-Devalmont, E., 1576.
Belot, E., 1490.
Benedicks, C., 1499.
Bergholm, C., 1526.
Berman, H. C., 1594.
Bethe, A., 1591.
Billieux, O., 1573.
Breuning, E., 1581.
Briner, E., 1582.
Brinkworth, J. H., 1544.
Bruins, E. D., 1569.
Buss, A. A., 1498.
Carvallo, J., 1556.
Chatley, H., 1489.
Chrec, C., 1574, 1575.
Compton, K. T., 1554.
Crehore, A. C., 1534.
Croze, F., 1531.
v. Czudnochowski, W. B., 1558.
Debierne, A., 1536, 1537, 1578, 1579.
Dyson, F. W., 1497.
Devalmont, Beignot-, E., 1576.
Dhar, N., 1580.
Dickinson, H. C., 1547.
Dittus, E. J., 1545.
Ehrenfest, P., 1493.
Elias, G. J., 1567.
Frankamp, C. A., 1570.
Frary, F. C., 1594.
Fredholm, I., 1499.
Garbasso, A., 1529.
Gascard, A., 1576.
Gibon, 1521.
Giebelhausen, H., 1586.
Gullstrand, A., 1524.
Gutton, C., 1565.
Gyllenberg, K. W., 1519.
Harper, C. H., 1593.
Hertzsprung, E., 1514, 1515.
v. Hevesy, G., 1592.
Hornig, G., 1517.
Horst, C., 1568.
Howes, H. L., 1533.
Innes, R. T. A., 1509.
Jaeger, W., 1543.
Jeffreys, H., 1500.
Jonson, E., 1589.
Jouaust , 1572.
Kahn, J., 1582.
Kalmus, H. T., 1593.
King, L. V., 1505.
Knipp, C. T., 1571.
Leathem, J. G., 1492.
Livens, G. H., 1549, 1550.
Lockyer, N., 1513.
Lorentz, H. A., 1530.
Lowry, T. M., 1587.
Ludwik, P., 1487.
Maass, O., 1546.
McIntosh, D., 1546.
Maldiney, T., 1525.
Mathews, J. A., 1566.
Mebius, C. A., 1491.
Nijland, A. A., 1520.
Oseen, C. W., 1559.
Osborne, N. S., 1547.
Owen, D., 1561.
Page, L., 1552.
Paneth, F., 1592.
Parker, R. G., 1587.
Perreau, E. F., 1577.
Przybyllok, E., 1503.
Ramsey, R. R., 1539.
Randall, H. M., 1527.
Reedy, J. H., 1595.
Rolla, L., 1584, 1585.
Ross, L. W., 1554.
Salles, E., 1553.
Savell, W. L., 1593.
Sawtelle, W. O., 1555.
Schenck, R., 1581.
Seares, F. H., 1516, 1518.
See, T. J. J., 1502.
Shapley, H., 1504, 1508.
Shapley, M. B., 1508.
Siegbahn, M., 1535.
Smith, C. F., 1541.
Solà, J. C., 1511.
Stebbins, J., 1507.
v. Steinwehr, H., 1543, 1590.
van der Stok, J. P., 1494, 1495.
Strutt, R. J., 1532.
Tolman, R. C., 1488.
Tressler, M. E., 1564.
Tropoff, T., 1591.
Uhler, H. S., 1528.
Valentiner, S., 1542.
Verain, L., 1557.
Vogel, R., 1583.
Voûte, J., 1509.
Wallot, J., 1542.
Wanach, B., 1503.
Weatherbrun, C. E., 1551.
Wedekind, E., 1568.
Weisberg, L., 1548.
Weiss, P., 1569, 1570.
Weissenberger, G., 1538.
Welo, L. A., 1571.
White, W. P., 1560.
Wolf, M., 1512.
Wood, A. B., 1540.
Worthing, A. G., 1562.
Wright, J. R., 1541.
Zeeman, P., 1523.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1915.

GENERAL PHYSICS.

1486. *Comparators for the Indian Government.* (Engineering, 100. pp. 179–182, Aug. 20; 209–211, Aug. 27, and pp. 232–235, Sept. 3, 1915.)—With a view to new triangulations in Baluchistan and Burma, a complete modern equipment of length standards was obtained, involving the great improvements introduced by the employment of invar wires for setting out base lines. It is now considered possible to set out base lines fifty times as fast as, and more accurately than on the old methods. In spite of the systematic ageing of the measuring wires by shocks, annealing, etc., experience shows that their re-standardisation is necessary before and after each base measurement. The 24-metre invar tapes or wires are compared in air with invar bars. These bars are of 4 m. length. Hence a comparator of 24 m. divided into six sections is necessary. A separate 4-m. comparator is required to compare the 4-m. bar with the 1-m. bar which is compared with a primary standard. The 4-m. comparator is used both for comparison of length and for determination of coefficient of expansion. The latter process is done in water. The equipment, made by the Cambridge Scientific Instrument Co., is carefully described with many photo-plates and diagrams. P. E. S.

1487. *Molecular Homology as shown by the Mechanical Properties of Metals at High Temperatures.* **P. Ludwik.** (Zeits. Vereines Deutsch. Ing. 59. pp. 657–664, Aug. 14, 1915.)—Describes experiments on the properties of Al, Pb, Cd, Cu, Mg, Ni, Zn, Sn, brass, German silver, cast iron, and cast steel, between room temperature and their respective melting-points. The properties investigated were ultimate tensile strength, the actual stress per unit cross-section at rupture, the degree of constriction at the breaking-point, and the change of cross-section up to the instant when constriction begins to take place. Special attention was paid to the behaviour of the metals at points of discontinuity due to changes of state. The idea of molecular homology is introduced, and instead of using ordinary temperatures the mechanical properties are plotted against "corresponding" temperatures, *i.e.* temperatures which are in the same ratio as the melting-points (absolute) of the respective metals. On this basis an explanation is given of the different effects of annealing on different metals as well as of the connection between the thermal coefficient of expansion and the heat capacity. Simple relations between these quantities, the heat of fusion, and the modulus of elasticity are deduced and the observed irregularities of many elements from Dulong and Petit's law are explained. The degree of agreement obtained in this way between the behaviour of diamond and that of other elements is shown by the following table :—

(Melting-point Temperature = T_s; Temperature Centigrade = t; Atomic Heat = a.)

"Corresponding" Temperature.	Lead.		Copper.		Aluminium.		Diamond.	
	t	a	t	a		a	t	a
$T_s/2$	272	6·2	406	6·4	192	6·4	2060	6 0 (?)
$T_s/4$	—123	5·8	66	5·9	—41	5·5	895	5·5
$T_s/10$	—213	5·0	—137	4·5	—180	3·0	194	3·2

J. W. T. W.

1488. *Similitude and Dimensions.* **R. C. Tolman.** (Phys. Rev. 6 pp. 219–233, Sept., 1915.)—The author has recently presented a new postulate, called the principle of similitude, which serves as a successful starting-point for the deduction of a considerable number of physical laws. There is a certain similarity between the methods of applying this new principle to the deduction of physical laws and the methods of applying the well-known principle of dimensional homogeneity, and the purpose of the present paper is to show :—(1) That the essential content of the two principles is in reality quite distinct, and (2) that it is possible to derive important relations from the principle of similitude that cannot be derived from the principle of dimensional homogeneity, and *vice versa.*

After discussing the two principles in detail the following relation betweeen them is stated : Where *dimensional* constants enter (as *e.g.* the gas constant R, heat capacity per mol.), the principle of dimensional homogeneity is of no avail in predicting the form of a relation, since we cannot tell beforehand what the dimensions of the constant are going to be. For such problems we must have recourse to the principle of similitude. On the other hand, when dimensional constants do not enter into the relation, although we may apply either principle, the principle of similitude is usually the less powerful since it merely prescribes invariance when the different measurements are multiplied by powers of a single arbitrary multiplier x, while the principle of dimensional homogeneity prescribes the more drastic requirement of invariance when the multiplications are carried out with a different arbitrary multiplier for each fundamental property. E. H. B.

1489. *Cohesion of Solids.* **H. Chatley.** (Phys. Soc., Proc. 27. pp. 448–460, Aug., 1915.)—It is remarkable that the force which links the particles of the earth to those of the distant sun is much better understood than that which connects those earth particles together. The most plausible hypothesis would seem to be that which identifies the two. Kelvin favoured this view, but there are difficulties.

Two salient facts arise from any investigation, viz. (*a*) The attractive force termed cohesion has a very minute range (being inappreciable beyond about 10^{-6} cm.), but appears to be considerably greater than gravitation at minute distances. (*b*) There is a repulsion between small particles of matter as well as attraction.

In order to appreciate the second fact correctly it is necessary to make a preliminary conjecture as to the nature of the ultimate particles of matter. Elaborate investigation has shown that solid matter has a whole series of discontinuities, namely:—(1) *Crystalline structure* bounded by interfaces, with occasional minute cavities between the crystals. In the case of "amorphous" solids it may, perhaps, be assumed that the crystals are of molecular dimensions. (2) *Molecules* consisting of a geometrically arranged group of two or more atoms bound by electrostatic (?) forces (chemical affinity) immensely superior in intensity to gravitation or cohesion. (3) *Atoms* consisting of electrons, each atom forming a dynamic complex of immense stability. (4) *Possible etheric sub-structure*, such as Osborne Reynolds' "granules" of "negative matter."

The elastic compressibility of solids shows that: (*a*) The molecules or the atoms in the molecules may be brought closer together; (*b*) Such closer proximity develops a mutual repulsion in the molecules, and "strain energy" is stored in the substance, which will return the parts to their original positions (or nearly so) when the compressing force is removed. Elastic tension similarly indicates the presence of a mutual attraction and separability. Kelvin was of opinion that cohesion could be explained by supposing the actual mass of substance to be concentrated into volumes quite small as compared with the whole volume. The density at such centres would be extremely high, and this intense density would, he thought, so increase the force of gravity between pairs of molecules very close together as to account for cohesion without necessitating any deviation from the inverse square law. The present author then calculates the distance between the molecules of an iron or steel bar to account for the known cohesion on this gravitational law. This is found to be of the order 10^{-24} cm., much less than the reputed diameter of an electron even! A second calculation is then made according to an inverse law of undetermined index, the Newtonian constant for gravitation being still retained. This results in making the cohesive force vary as the inverse *sixth* power. Other considerations are also discussed.

E. H. B.

1490. *Deficit and Excess of Gravity upon Continents and Islands referred to the Isostatic Condition of the Terrestrial Crust.* **E. Belot.** (Comptes Rendus, 161. pp. 139–141, Aug. 9, 1915.)—The author has previously shown [see Abs. 1496 (1914)] how on the hypothesis of a primitive austral deluge, the sea floor traversed by ocean currents in a south-north direction, becomes ever denser, whilst the lighter material driven forward becomes the foundation of continents and is in hydrostatic equilibrium with the adjacent magma. The critical deluge, whose currents had a temperature of about 364°, determined the fundamental features of terrestrial architecture, and has been slowly succeeded by a normal deluge, which completed between 364° and 100° the primitive ocean basins to a depth of 2000 m. Within this distance of 2000 m., almost all geological events have taken place, and in consequence these cannot be contradictory to the theory of a primitive austral deluge. One of the results on this theory is a variation in density which should exist between the material beneath ocean floors and under continents, and which will be manifested by differences in the values of gravity. The present paper deals mathematically with this aspect of the theory, and formulæ are established for calculating the deficit or excess of gravity upon continents and islands from the standpoint of the isostatic condition of the terrestrial crust.

H. H. Ho.

1491. *Number of Molecules per Square Centimetre in the Surface between a Liquid and its Saturated Vapour.* **C. A. Mebius.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 10. No. 20. pp. 1–22, 1915. In Swedish.)—The author's calculations, based on the observations of Young [Abs. 1785 (1910)] and those of Ramsay and Young, lead to the following conclusions :—If ρ_1 and ρ_2 represent the densities of a liquid and its saturated vapour at one and the same temperature, the expression $\frac{1}{2}(\rho_1^{2/3} + \rho_2^{2/3})$ is approximately constant, independently of the temperature. The two sides of a certain area in the limiting surface between a liquid and its saturated vapour contain together very nearly the same number of molecules at different temperatures ; as the temperature rises, the diminution in the number of liquid molecules is counterbalanced by the increase in the number of vapour molecules. The law of corresponding states is, so far as molecules are concerned, a good first approximation, but small individual differences are observed between different substances. For 47 compounds the numbers of molecules per cm.^{2} at the critical temperatures have been calculated, the values varying from 116·5 to 502·8 billions.

T. H. P.

1492. *Some Applications of Conformal Transformation to Problems in Hydrodynamics.* **J. G. Leathem.** (Roy. Soc., Phil. Trans. 215. pp. 439–487, Sept. 22, 1915.)—Mathematical.

1493. *Capillarity Theory of Crystalline Form.* **P. Ehrenfest.** (K. Akad. Amsterdam, Proc. 18. pp. 173–180, Sept. 8, 1915.)—A general discussion of this subject.

E. H. B.

1494. *Relation between Meteorological Conditions in the Netherlands and some Circumjacent Places. Atmospheric Pressure.* **J. P. van der Stok.** (K. Akad. Amsterdam, Proc. 18. pp. 310–320, Sept. 8, 1915.)—The methods of correlation are employed to ascertain to what extent deviations of pressure from the normal in Holland may be determined from the simultaneous deviations from the normal at certain surrounding stations. For reasons which are set forth, the three winter months Dec. to Feb. only are dealt with. In the first part of the inquiry 10-day means of pressure published by the "Deutsche Seewarte" are employed. Pressure variations at the Helder are correlated with those at Valencia (Ireland), Clermont, Milan, Neufahrwasser, and Christiansund. The partial correlation coefficients are worked out, and it is found that Clermont exercises the greatest influence on Helder, while Milan is the only one of the stations which has no appreciable effect. This is as might be expected when it is remembered that Milan falls within the influence of the Alps and the Mediterranean. Excluding Milan, it is found that the pressure oscillations at Helder may be accounted for to the extent of 94 % by means of the oscillations at the four remaining stations. It thus appears that local influences play only a subordinate part in the pressure variations at Helder, and that these latter are mainly controlled by the surges of pressure which pass over the station and the surrounding countries. The investigation only covers the winter months, so that this conclusion may not be applicable to the summer. For confirmation of these results two independent sets of three stations are taken and correlated with De Bilt. The results corroborate those already found, and it is concluded that barometric oscillations at a central point may be determined with great accuracy from as few as three well-chosen surrounding stations. J. S. Di.

1495. *Relation between Meteorological Conditions in the Netherlands and some Circumjacent Places. Difference of Pressure and Wind.* **J. P. van der Stok.** (K. Akad. Amsterdam, Proc. 18. pp. 321–327, Sept. 6, 1915.)—In a previous paper an investigation was made into the relation between the pressure gradient between certain stations and the surface wind [see Abs. 642 (1912)]. The results were not entirely reliable, and in the present discussion statistical methods are employed to establish the connection. Variations from the mean value of the pressure-differences between Flushing and five surrounding stations ($x_1, x_2, \ldots x_5$) are related with the Flushing wind ($x_6 =$ North component, $x_7 =$ East component) by empirical equations of the type—

$$x_6 = b_{61} x_1 + b_{62} x_2 + \ldots + b_{65} x_5$$
$$x_7 = b_{71} x_1 + b_{72} x_2 + \ldots + b_{75} x_5.$$

The values of b_{61}, b_{62}, etc., are then determined from the observational data by the method of least squares. Making use of the resultant equations, it is found that a positive pressure-gradient in the direction of Valencia produces a SE. wind at Flushing, in the direction of Biarritz an E. wind, of Munich a NE. wind, of Neufahrwasser a NW. wind, and of Lerwick a SW. wind. The results both for velocity and direction of the wind are set out in a table, the surface wind which corresponds with each type of pressure gradient being given. A similar piece of work is carried out in which the average wind from four stations in the Netherlands is used in place of that from Flushing only, and by this means more regular results are obtained. J. S. Di.

1496. *Volcanic Dust Veils and Climatic Variations.* **H. Arctowski.** (New York Acad. Sci., Ann. 26. pp. 149–174, June, 1915. Nature, 96. p. 80, Sept. 16, 1915. Abstract.)—Preliminary investigation on temperature records led to the conclusion that a general rise in the temperature of the atmosphere was probably due to an increase in the solar constant. Further reductions of the curves with special reference to departures from monthly means, and including the epochs of great volcanic eruptions such as Krakatoa (1883) and Katmai (1912), now show that the short-period variations of temperature have nothing in common with the presence or absence of volcanic dust veils. C. P. B.

1497. *Construction of the Heavens.* **F. W. Dyson.** (Nature, 96. pp. 42–46, Sept. 9, 1915. Paper read before the British Assoc. at Manchester.)—Our knowledge of the fixed stars is mainly derived from two main types of investigation: (1) measurement of small changes in the positions of the stars; (2) the analysis of the light received from them and the measurement of its amount. The first exact insight may be ascribed to Herschel, who, by means of telescopes of his own construction made the celestial surveys with which his name is associated. The first successful determinations of stellar distances were the parallaxes measured by Bessel, Struve, and Henderson in 1838, and the application of the method to double-star systems permitted the evaluation of the masses, from which it was found that the masses of stars have not a very great range, but lie between 40 times and $\frac{1}{10}$th of the mass of the sun. On the other hand, when the absolute luminosities of the stars, the distances of which have been measured, are calculated, it is found that they exhibit a very great range; Sirius, for example, radiating 48 times as much as the sun, and 84 Groombridge only 1/100th part. Further, at least among the stars near the solar system, the absolute luminosity appears to vary with the type of spectrum; the luminosity decreases as the type of spectrum changes from A to M, *i.e.* from the blue stars to the red stars. At the commencement of the present century the parallaxes of about 80 stars were known with some accuracy; there is now an international scheme of co-operation for the determination with all modern improvements of about 1100 stars.

Velocities in the line of sight were first determined by Huggins in the 'sixties, but results of reliable accuracy were not obtained until the application of photography by Vogel in 1890. Continual progress has since been made, and the velocity may now be determined with an accuracy of 0·25 km. per sec. for bright stars showing sharp spectrum lines. From a large programme involving some 1200 stars Campbell, at the Lick Observatory, has been able to deduce as a reliable value for the solar motion in space 19·5 km. per sec. A most notable feature of these radial velocities is that mean velocities, after correction for the sun's motion, increase as the type of spectrum varies from B to M.

Proper motions of stars are determined by comparisons of positions at different epochs, and increase with accuracy as the time interval increases. At first these results were difficult to interpret, until the announcement by Kapteyn in 1905 that the proper motions had a general tendency towards two different points in the sky, thus originating the modern study of star-streaming, extended by Eddington and Schwarzschild. It is interesting to find that this star-streaming is corroborated by the discussion of observations of radial velocities. Discussion of the whole question leads to the view that the sun is some distance from the centre of the stellar system. Another discovery of importance was made by Boss in 1908, when he announced the existence of groups of stars scattered over a considerable region of the sky, all moving towards the same point with nearly the same angular velocity. Russell has suggested that the consideration of intrinsic brightness leads to the idea that among the stars of spectrum class further advanced than A there are two classes at each level, one set brighter and the other set fainter than the sun.

Future research is expected to give more complete knowledge of the relation between proper motion and spectral type, for which the new catalogue in preparation at Harvard College Observatory by Miss Cannon will serve as reference for stars down to the ninth magnitude.

For the more distant parts of the universe proper motions are of little use, and for these information is sought from determinations of stellar photometry, colour, and spectrum. An example of this inductive method is in the work of Hertzsprung; from a knowledge of the characteristics of the Cepheid variables in the small Magellanic cloud and their apparent magnitude, he deduced that the distance of the cloud is of the order of 10,000 parsecs.

Measurements of stellar photometry on a large scale were for some time only made at Harvard College Observatory by the visual method, but of late years this photographic method has been taken in hand at various stations, and an effort is being made to obtain a standard scale of stellar magnitude.

This is of fundamental importance in counts of numbers of stars to determine the star-density in various directions. Up to the present the results agree in showing a continuous increase of stars as we proceed from the pole of the Galaxy to the Galactic Plane. The measure of colour may to some extent serve as an indicator of distance, as it is found that of near and distant stars of identical spectrum type the distant star is deficient in blue light. Whether this is due to absorption in space remains to be determined. C. P. B.

1498. *Distribution of Solar Activity Areas in Longitude.* **A. A. Buss.** (Observatory, No. 491. pp. 355–360, Sept., 1915.)—Graphical plotting of the published positions of sun-spot groups suggests that there is a tendency of spot outbreaks to occur in localised tracts at intervals of about 60° in longitude, or in some multiple of this angle. A table is given showing the data for certain spots during 1914. C. P. B.

1499. *Photographs of Solar Eclipse,* 1914 *August* 21. **C. Benedicks** and **I. Fredholm.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 10. No. 24. pp. 1-6, 1915.)—Photographic observations of the Solar Eclipse of 1914 Aug. 21, were obtained by the authors at Sundsvall, using a telephoto-camera of about 2 m. focal length, and chromo-isolar plates. Reproductions of several of the photographs are included, but no special details are recorded. C. P. B.

1500. *Internal Structure of Earth and Moon.* **H. Jeffreys.** (Roy. Astron. Soc., Mem. 60. 6. pp. 187–217, 1915.)—A discussion is given of the various hypotheses which have been formulated as to the internal structure of the earth, considering it to have a homogeneous metallic core surrounded by a rocky crust. The hypotheses in which either the shell or the nucleus is supposed permanently elastic have been shown to be highly improbable, so that the earth has the hydrostatic form throughout, Wiechert's hypothesis being the only possible one of this type. The paper further explains the large ellipticities of the moon by supposing it to have solidified while much nearer the earth than it is now. The fact that the moon always turns the same face towards the earth is shown to be not necessarily due to internal tidal friction, as in the absence of this the amplitude of the free libration in longitude would only increase with extreme slowness. If this amplitude had been reduced to a small amount before solidification, tidal friction would not be required in order to keep it small. C. P. B.

1501. *Perturbations of the Satellite of Neptune.* **G. Armellini.** (Accad. Lincei, Atti, 24. pp. 569–574, April 19, 1915.)—Discusses the secular anomalies of the ascending node and inclination of the orbit of Neptune's satellite observed since 1848. These amount to as much as a degree, and they indicate a secular motion of the line of nodes and a diminution of the inclination nearly proportional to the time. The author refers to the work of Tisserand, Struve, Barnard, Rice and Hammon, Wirtz, and especially Dyson on this subject. Tisserand's supposition that the perturbations are due to an unobservable ellipticity of the planet's disc imply too great an angle between the satellite's orbit and the equatorial plane of the planet. The author puts the question whether the perturbations are due to a second satellite, too small to be visible, and promises to discuss this question in detail in a further note. E. E. F.

1502. *Capture Theory of Satellites.* **T. J. J. See.** (Observatory, No. 490. pp. 330–333, Aug., 1915.)—The author objects to certain statements in an article by A. C. D. Crommelin [Abs. 996 (1915)], and discusses them in detail. With regard to the question of eccentricities, he states that one cause only is admissible as having obliterated the eccentricities of the orbits of the planets and satellites, namely, the secular actions of a resisting medium consisting of smaller bodies. The absorption of such small masses adds to the attractive power of the larger masses, and thus draws them together; while the tangential action rounds up the orbits, so that the almost circular form of the orbits can be ascribed to no other cause. The author further claims that his Capture Theory is a confirmation, and extension of, Herschel's idea of "Clustering Power." Further criticism is also made of the work of Darwin on Periodic Orbits. C. P. B.

1503. *Variation of Latitude.* **E. Przybyllok.** (Astron. Nachr. No. 4811. Nature, 96. p. 123, Sept. 30, 1915. Abstract.)—Measurements of the altitude of the celestial pole show a daily fluctuation in its amount varying directly with the altitude of the sun, suggesting some temperature effect on the refraction of the air inside and outside the observatory covering the telescope. **B. Wanach.** (Astron. Nachr. No. 4812. Nature, 96. p. 123, Sept. 30, 1915. Abstract.)—Some doubt having been thrown on the reality of the Kimura "*z*" term, a new term is taken as a negative declination correction and new values are derived for the group corrections of the six northern international stations. The differences between successive groups show an annual oscillation having a maximum in spring and a minimum in autumn, while the amplitudes for the three continental stations exceed those of the maritime stations, suggesting that some meteorological effect is operative. C. P. B.

1504. *Eclipsing Binaries.* **H. Shapley.** (Princeton Univ. Observatory, Contrib. No. 3. Observatory, No. 491. pp. 367–370, Sept., 1915.)—Results for 90 stellar systems of the eclipsing binary class are collected for the general discussion of the physical constitution of various types. Five types are indicated, examples being S Cancri (eclipse total); U Cephei (eclipse total and central); RX Herculis (eclipse partial); U Coronæ (eclipse partial); WZ Cygni (stars ellipsoidal). In the first four classes the stars are spheroidal, and the max. light constant, while in the fifth the max. light is not constant. The value of spectroscopic in conjunction with photometric data is emphasised by the discussion of the systems of α Herculis, β Lyræ, and ν Puppis. Most of the solutions are given on the alternative hypotheses that the surfaces are uniformly bright, or that the light is gradually absorbed towards the limb. The results are compared with the values given by Darwin for figures of equilibrium of two masses of incompressible fluid. C. P. B.

1505. *Density of Molecules in Interstellar Space.* **L. V. King.** (Nature, 95. pp. 701–703, Aug. 26, 1915.)—Various investigators in recent years have endeavoured to determine the evidence for the existence of some form of absorbing medium in interstellar space. [Abs. 625 (1909); 376 (1913).] The author of the present note attempts to estimate the average density of residual molecules on the assumption that the extinction is due to attenuation by scattering. Assuming the residual gas to be hydrogen, the interstellar molecular density is computed to be $\eta = 1{\cdot}28 \times 10^5$ hydrogen molecules per cm.^{3}. This would be equivalent to a total amount of matter of the order 1/88 × earth's mass in a sphere having a radius equal to that of the orbit of Neptune, and it is improbable that such a quantity could have any noticeable effect on planetary motions. The corresponding density in interstellar space is given as $6\cdot 3 \times 10^3$ times the sun's mass per cubic parsec. If the presence of this quantity of matter is verified, it becomes of importance to investigate its behaviour with respect to gravitational potential, and it should be taken into account in questions of stellar dynamics. C. P. B.

1506. *Radial Velocities of 500 Stars.* **W. S. Adams.** (Mt. Wilson Solar Observatory, Contrib. No. 105. Astrophys. J. 42. pp. 172–194, Sept., 1915.)—The tables of radial velocities presented are the result of moderate dispersion work on stars of various classes of spectrum, and show for each object the R.A., Decl., magnitude, spectral type, total proper motion as given by Boss, angle between star and sun's apex, observed radial velocities at Mt. Wilson and elsewhere, radial velocities corrected for the solar motion. The observations are discussed from the point of view of interrelationship between proper motion, radial velocity, and spectral type. The Mt. Wilson results appear at first to indicate that among the very distant stars the change in radial velocity with spectral type is slight. Taking the proper motion and spectral type together there is a decided increase of radial velocity with increase of proper motion for stars of the same spectral class, while there is a definite increase of radial velocity in passing from stars of class B, through those of classes A, F, G. The main feature of interest in this connection is the low average velocity found for the very distant stars of types F–M. C. P. B.

1507. *Eclipsing Variable δ Orionis.* **J. Stebbins.** (Astrophys. J. 42. pp. 133–147, Sept., 1915.)—The star δ Orionis has been suspected of variability by several observers, but hitherto no definite confirmation is available. A large number of observations have been made with the selenium photometer, resulting in the conclusion that the star is an eclipsing variable with two minima in agreement with the spectroscopic orbit, periods 5·7325 and 3·20 days. The light between minima is also variable, there being an increase near periastron, but this effect may be due to ellipticity of figure or other causes. The total light-range is about 0·15 mag., of which 0·08 mag. is due to the eclipses. The minima are not symmetrical about the times of greatest eclipse, and suggest that the surface brightness of each apparent disc is not uniform, but that each body is brighter on the front side in its motion in the orbit. The elements of the system can only be determined within certain limits, but it is stated that the mean density of the system is 0·006 that of the sun, the larger component being at least 5 times, and the smaller at least 1·4 times, the solar radius. C. P. B.

1508. *Light-Curve of XX Cygni.* **H. Shapley** and **M. B. Shapley.** (Mt. Wilson Solar Observatory, Contrib. No. 104. Astrophys. J. 42. pp. 148–162, Sept., 1915.)—The variable star XX Cygni, discovered by Madame Ceraski in 1904, is interesting as being the shortest-period variable known, and has been distinguished from the Cepheids in that its range is said to be greater visually than photographically. An investigation was made with the 60-in. reflector at Mt. Wilson during Aug. and Sept., 1914, March, 1915, using Seed "27" and Cramer "Instantaneous Isochromatic" plates for the records of photographic and photo-visual magnitudes. The observations are tabulated and some of the results plotted as light-curves. Within the errors of observation, the time of maximum is practically the same photographically and photo-visually, with some slight indication that the photographic maximum may be somewhat later than the other. In the amplitudes, however, there are very marked differences. The colour and magnitude at minimum appear to be constant, suggesting that the outstanding irregularities occur at maximum. It is noted that the light-curves appear to be different on different nights, the maximum peaks varying from angular to dome-shaped. No instances were found where the curves were very different in consecutive periods during the same night. Careful comparison of the plates result in the conclusion that the visual range does not exceed the photographic, thus bringing the star's variation into agreement with that of other Cepheid variables. C. P. B.

1509. *Proper Motions of Stars near ω Centauri.* **R. T. A. Innes** and **J. Voûte.** (Union Observatory of S. Africa, Circ. No. 25. pp. 195–200, June 2, 1915.)—Measurements have been made with the blink-microscope on two plates of the region near ω Centauri taken at an interval of nearly 28 years. No star in the cluster or its immediate neighbourhood shows any proper motion as great as 0·5″ in 28 years. On the plate covering some 4 square degrees about 80 stars have been detected showing a measurable proper motion of about 1·0″ in the 28 years. C. P. B.

1510. *Olbers' Method of calculating Parabolic Orbits.* **T. Banachiewicz.** (Comptes Rendus, 161. pp. 122–124, Aug. 9, 1915.)—Oppolzer has shown that the method devised by Olbers admits of a multiple solution, and the computations, say for cometary orbits, become very complicated. A simplified method is indicated, involving the use of a transparent abacus inscribed with determined families of curves. C. P. B.

1511. *Stellar Proper Motions by Stereoscopic Photography.* **J. C. Solà.** (Comptes Rendus, 161. pp. 121–122, Aug. 9, 1915.)—Photographs taken with a special camera of 160 mm. aperture, 800 mm. focal length, at epochs differing as far as possible, show stereoscopic relief when viewed in an ordinary stereoscope if any of the objects have moved during the interval. Numerous stars with definite proper motion were detected in this way on plates taken 1912 July 12 and 1915 July 20. C. P. B.

1512. *Stellar Proper Motions by Stereoscopic Photography.* **M. Wolf.** (Astron. Nachr. No. 4811. Nature, 96. p. 123, Sept. 30, 1915. Abstract.) —Quantitative determinations of stellar proper motions have been successfully obtained by means of stereoscopic photographs taken at an interval of 12 to 8 years. The star field was in the region of σ Leonis, and the yearly motions found vary from 0·31″ to 1·18″. [See preceding Abs.] C. P. B.

1513. *Stellar Classification.* **N. Lockyer.** (Nature, 96. pp. 88–89, Sept. 23, 1915.)—Further discussion is given of the scheme of stellar classification embodying the idea of stars increasing and stars decreasing in temperature, with cross-references to the corresponding types in the Harvard Classification. For the continuance of the work, further photographs of 854 stars have been taken, and a table is being prepared showing details. C. P. B.

1514. *Effective Wave-lengths of Stars in Cluster N.G.C. 1647.* **E. Hertzsprung.** (Mt. Wilson Solar Observatory, Contrib. No. 100. Astrophys. J.

42. pp. 92-110, July, 1915.)—Details are given of the determination of the effective wave-lengths in the spectra of 184 stars of the cluster N.G.C. 1647, using the 60-in. reflector at Mt. Wilson, in conjunction with a coarse diffraction grating having spacings of 3 mm. The photographs show for each star a central image and first-order spectra on either side. The distance between these two spectra for different stars serves as a measure of their different colour. Tables are given showing the photographic magnitude and effective wave-length of each star, and also of the effective wave-lengths of stars of certain spectral classes. C. P. B.

1515. *Effective Wave-lengths of absolutely Faint Stars.* **E. Hertzsprung.** (Mt. Wilson Solar Observatory, Contrib. No. 101. Astrophys. J. 42. pp. 111-119, July, 1915.)—Evidence is considered bearing on the view that whereas absolutely bright stars may have all colours between red and white, the range of colour within which the stars are distributed becomes more limited as the absolute brightness diminishes. The discussion is based on special photographs taken with the 60-in. reflector at Mt. Wilson, chiefly of faint stars having large well-known parallaxes [see preceding Abs.]. The effective wave-lengths were reduced to the same zenith distance. Considered in relation to the behaviour of a black body, the graph showing the relation of absolute magnitude to effective wave-length indicates a decided difference in the behaviour of bright and faint stars. The unknown factor causing this appears to become apparent about absolute magnitude + 3. Consideration of possible physical features leads to the conclusion that differences in mass or density are not sufficient to explain the constancy of colour of stars between the absolute magnitudes + 3 and + 8. It is suggested that the absolute magnitude + 8, corresponding to the temperature 3400° abs. of a black body of the size of the sun, represents that stage of a cooling star at which the formation of relatively dark, solid matter on its surface begins, the remaining fluid part giving practically all the radiation. Further investigation is proposed in the examination of absolutely dark stars for variability. C. P. B.

1516. *Colour-indices in Cluster N.G.C.* 1647. **F. H. Seares.** (Mt. Wilson Solar Observatory, Contrib. No. 102. Astrophys. J. 42. pp. 120-132, July, 1915.)—Effective wave-lengths for some 200 stars in Cluster N.G.C. 1647 [Abs. 1514 (1915)] were utilised in an investigation of the photographic and photo-visual scales of magnitude for stars near the North Pole by comparison plates of the Pole and cluster, arrangements being made to minimise atmospheric irregularities by work on different nights. Examination of these plates gave the colour-indices of the stars. Comparison of these with the effective wave-lengths then afforded a control on the relative errors of the magnitude scales, the limits for the work in question being between photographic magnitudes 11·5 and 15. Within this interval the two series of colour-indices show the same increase in the mean colour with increasing magnitude. The relative errors in the magnitude-scales seem to be within the uncertainty affecting the reductions of the effective wave-lengths. C. P. B.

1517. *Short-period Variable Stars.* **G. Hornig.** (Astron. Nachr. No. 4808. Nature, 95. p. 655, Aug. 12, 1915. Abstract.)—Results are given of observations by Argelander's method of several bright variable stars of short period, with the elements determined for each system. C. P. B.

1518. *Absolute Scale of Photographic Magnitudes.* **F. H. Seares.** (Nat. Acad. Sci., Proc. 1. p. 307, 1915. Nature, 95. pp. 654–655, Aug. 12, 1915. Abstract.)—A long investigation has been made with the 60-in. reflector at Mt. Wilson for the determination of absolute scales of photographic and visual stellar magnitudes, utilising the method of comparison of two series of images taken with a known variation of intensity between the exposures. The variations were introduced by means of wire gauze screens and circular diaphragms. The photographic scale for stars from 10–18 mag. was determined by exposures of 11 minutes or less for one set, and 30–60 mins. for the other set, the average difference between the mean scales for the two series being only 0·015 mag. Extension to fainter stars was obtained by longer exposures extending to 4 or 5 hours, with a resulting limiting magnitude of about 28. The entire series of photographic magnitudes of 617 stars was reduced to the international zero by making the mean brightness of white stars (type A_0) near 6 mag. equal to the mean of their visual magnitudes in the Harvard Scale.

The photo-visual scale was determined in a similar manner by the use of isochromatic plates, final values being given for 339 stars between magnitudes 2·1 and 17·5. About 300 stars are common to the two lists, and from these the colour-indices have been determined; the discussion of these confirms previous conclusions that faint stars are relatively redder than bright stars.
C. P. B.

1519. *Absolute Motion of Parallax-stars.* **K. W. Gyllenberg.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 10. No. 18. pp. 1–13, 1915.)—Tables are given showing the results of calculations of the absolute velocities of 160 stars of well-determined parallax, and the various groupings of these velocities in relation to spectral type. The distribution of the absolute velocities of stars with parallax greater than 0·025″ is approximately represented by an ellipsoid of revolution, flattened in the plane of the Milky Way. A principal vertex similar to that found from proper motions or radial velocities was not detected.
C. P. B.

1520. *R Corona Borealis.* **A. A. Nijland.** (Astron. Nachr. No. 4809, p. 184. Nature, 95. p. 684, Aug. 19, 1915. Abstract.)—Notes on observations of the irregular variable R Corona Borealis, showing that while for 2¼ years it has been constant at about 6·4 mag., it was estimated to be 7·1 mag. on July 24, and on July 29 still fainter, 7·6 mag. Minima were also observed in 1912; on March 8 it was 10·2 mag.; on May 13 about 8·2 mag.
C. P. B.

LIGHT.

1521. *Stereo-radioscopy.* **Gibon.** (Comptes Rendus, 161. pp. 240–243, Aug. 30, 1915.)—A new stereoscopic method requiring no additional apparatus is one in which use is made of either two Röntgen tubes or a small tube with two anti-kathodes and a diaphragm placed between the tube and the patient. This diaphragm is composed of sheets of metal impermeable to Röntgen rays except for a window of variable size. A second method of viewing directly in relief, images projected by the rays upon a fluorescent screen consists in employing a special screen made of a plaited sheet of metal with either two Röntgen tubes or a single tube with two antikathodes. A third method of viewing directly in relief upon the screen the form of fractures and the position of projectiles consists in employing two Röntgen tubes with two double stops in such a manner that each eye perceives only the projection from the tube corresponding to it. Details of each of these methods are given. A. E. G.

1522. *Use of Compensators, bounded by Curved Surfaces, in Displacement Interferometry.* **C. Barus.** (Am. J. Sci. 40. pp. 299–308, Sept., 1915.)—The difficulty of diffuse interference patterns obtained with large dispersion may be overcome, in part, by the use of compensators with curved faces, the case then becoming similar to the conversion of the usual interference colours of thin plates into Newton's rings. A cylindric lens with its elements normal to the slit is chiefly in question, but an ordinary lens also presents cases of interest because of the easy conversion of elliptic into hyperbolic patterns, and the lens is more usually available. A very promising method consists in the use of compensators of equivalent thickness, but of different dispersive powers, crown and flint glass, for instance. These experiments are in progress. A description is here given of experiments in which a lens or a doublet is used as a compensator, the latter part of the paper being concerned with telescopic interferences. A. W.

1523. *Fresnel's Coefficient.* II. **P. Zeeman.** (K. Akad. Amsterdam, Proc. 18. pp. 398–408, Sept. 8, 1915.)—This second paper gives the experimental details of the work whose main result was contained in the first [see Abs. 682 (1915)]. One series of experiments was made with yellow, green, and violet (4358) mercury light. But as Fresnel's coefficient changes very slowly with the wave-length, such a high homogeneity of the incident light is unnecessary. Further, as to the intensity of the light it is even desirable to work with a limited part of a continuous spectrum. Accordingly, in a second series of experiments, the author analysed the light of an electric arc (12 amps.) with a constant-deviation spectroscope. Many other details are given and the paper includes a diagram on which are plotted two graphs for the theories of Lorentz and of Fresnel and finally a graph for the experimental result. This lies almost in coincidence with that for Lorentz, and quite apart from that for Fresnel. E. H. B.

1524. *Diffraction Grating.* **A. Gullstrand.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 10. No. 14. pp. 1–10, 1915.)—In this paper the author treats first the plane diffraction grating from the standpoint of geometrical optics, and then extends the ideas to diffraction by a space grating. The theory developed yields results in agreement with some derived by v. Laue on the undulatory theory. A. W.

1525. *Retarding of Development produced by addition of Sugar to Metol-Hydroquinone Developer.* **T. Maldiney.** (Comptes Rendus, 161. pp. 73-76, July 26, 1915.)—It is usual to add water or a few drops of potassium bromide to the developer in order to retard the appearance of the image during development. It is now shown that the addition of sugar produces results similar to those obtained with potassium bromide. Tables of results are given which lead to the above conclusion and, in addition, indicate that the diffusion of the developer into the gelatine diminishes in proportion as the amount of added sugar increases. It therefore appears that the retarding action produced by the sugar must be attributed for the most part to a physical cause, the great viscosity given to the bath making slower the rate of penetration of the solution into the emulsion.

Experiments with other developers are being continued. A. E. G.

1526. *Polarisation by Gratings in the Visible Spectrum.* **C. Bergholm.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 10. No. 22. pp. 1-10, 1915.)—The gratings employed were made by subjecting plane glass plates, 0·1 mm. thick and free from double refraction, to kathodic deposition in a discharge bulb which had been repeatedly washed out with hydrogen. The metallic mirrors thus obtained were ruled with parallel scratches, a microscope showing these as well-defined lines. A Brace half-shadow apparatus was used to measure the phase variation of the undeviated beam of light going through such a grating. The majority of the gratings used showed the Du Bois effect. A table is given showing the phase-difference for the colours red, green, and blue as the number of scratches on the metallic mirror was increased, and it is seen that the absolute value of the phase-difference depends largely on the number of scratches, while the dispersion of the phase effect is independent of the number. The phase-difference also depends to a large extent on the refractive index. A. W.

1527. *Infra-red Arc Spectrum of Barium.* **H. M. Randall.** (Astrophys. J. 42. pp. 195-202, Sept., 1915.)—The paper is in continuation of a former one noted in 1911 [Abs. 1365 (1911)]. A difficulty often experienced in consequence of the unsteadiness of arcs fed with fused salts has been considerably lessened by the use of relatively large currents, 70 amps. or over from a 220-volt circuit, in place of the 15-25-amp. currents formerly employed. Tables are given of the wave-lengths of lines recorded from λ9527 to λ30933. Some discussion is given of the possible series relationships between certain lines in relation to corresponding series in the spectra of Ca and Sr.

C. P. B.

1528. *Thiele's "Phase" in Band Spectra.* **H. S. Uhler.** (Astrophys. J. 42. pp. 72-91, July, 1915.)—In the evaluation of the "phase" c in Thiele's series formula for band spectra, $\lambda = f[(n+c)^2]$, it is shown that the older methods of calculation are too complicated for practical purposes, and a new method for determining its value at different places along a band is developed, and illustrated by examples taken from measures of band spectra on high-dispersion photographs. Contrary to Thiele's view, the phase c is shown to be variable for the α and δ series of the λ5165 carbon band, and the

two series starting from the first head of the λ3883 cyanogen band are shown to be correlated according to the scheme of combination proposed by Thiele. Evidence is presented suggesting that other of his hypotheses are invalid.
C. P. B.

1529. *Simultaneous Action of Electric and Magnetic Fields on the Red Line of the Hydrogen Spectrum.* **A. Garbasso.** (N. Cimento, 9. pp. 376–381, May–June, 1915.)—According to Voigt's theory [Abs. 32, 1257 (1914), 451 (1915)] the simultaneous effects of an electric and a magnetic field on the electrons of Voigt's atom lead to the simple superposition of the Zeeman phenomenon on those of Stark and Lo Surdo. Experiment shows that this is actually the case with the H_α line of the hydrogen spectrum, which appears to be the only one capable of direct test.
T. H. P.

1530. *Width of Spectral Lines.* **H. A. Lorentz.** (K. Akad. Amsterdam, Proc. 18. pp. 134–150, Sept. 8, 1915.)—A mathematical treatment of the subject, based on the electron theory of absorption.
A. W.

1531. *Emission Spectra of the Common Gases.* **F. Croze.** (Ann. Physique, [IX], 1. pp. 35–134, 1914.)—The examination of the lines and bands is extended also into the infra-red as far as photographic methods allow (Lumière and Wratten and Wainwright pan-chromatic plates), up to λ9000 Å.U.; the Zeeman-effect is particularly studied. The gases examined are hydrogen, nitrogen, oxygen, and many tables are given. Most of the experiments were made in Geissler tubes. A great number of new lines and bands were discovered, and their wave-length, resolution, and series determined. New lines are: 98 lines in the second hydrogen spectrum λ6852 to 8029; 31 lines in the elementary oxygen spectrum λ5316 to 7152; 2 bands in the kathodic oxygen spectrum with their heads at λ6853 and 5007; 16 bands in the first positive group of nitrogen, maximum λ9108. The Zeeman-effect is proved to exist in a great many cases, also of unresolved bands, in which it had been assumed not to exist. It is not observed in the second (positive and negative) nitrogen groups, in the spectrum of Swan, in the CO spectrum and in the cyanogen bands of group 3883, nor in the tails of the bands of cyanogen which the author discovered with the aid of self-induction sparks. But resolution was possible, with sufficient dispersion, in many cases in which it had failed—for instance, also in the bands of calcium fluoride. The author considers that resolution should in all probability always be possible, and that there is no criterion for the existence or non-existence of the Zeeman-effect. Further researches are needed.
H. B.

1532. *Fluorescence and Resonance of Sodium Vapour.* II. **R. J. Strutt.** (Roy. Soc., Proc. 91. pp. 388–395, June 1, and pp. 511–523, Aug. 2, 1915.)—Describes in much greater detail the author's experiments on the fluorescence and resonance of Na-vapour, the chief results of which have previously been given [Abs. 1045 (1915)].
A. W.

1533. *Fluorescence of Frozen Solutions of Uranyl Salts.* **H. L. Howes.** (Phys. Rev. 6. pp. 192–206, Sept., 1915.)—An investigation of the fluorescence spectra of uranyl salt solutions between 20° and —185° C. The sulphate, chloride, and nitrate as well as a few double salts were examined, in aqueous, acid, and alcoholic solutions through a wide range of dilutions. Slow cooling causes a proportionate increase in intensity of all the bands, accompanied by a diminution in width and a tendency towards resolution. A general shift towards the violet is noticeable down to a critical temperature. Occasionally an extreme red or blue band does not join in the constant-interval series and a few bands shift abnormally on cooling. The simple and double nitrates each show different spectra according as they are cooled slowly or suddenly and the explanation is offered, that when a radically different spectrum is produced a different hydrate is formed. The various other anomalous shifts are explained on the lines of Nichols and Merritt's views that the bands in such spectra are complex, and consist of overlapping components which vary relatively in intensity with changes of temperature. The paper is fully illustrated with the fluorescence curves at the various temperatures. Some measurements also were made of the distribution of energy in the bands, using an acetylene flame as comparison standard. C. S. G.

1534. *Diamond Constructed with Theoretical Carbon Atoms.* **A. C. Crehore.** (Phil. Mag. 30. pp. 257–270, Aug., 1915.)—Study of the Röntgen-ray spectra has shown that in the diamond each carbon atom is at the centre of a regular tetrahedron, and the author has succeeded in constructing, from theoretical carbon atoms, a model of such a crystal by methods similar to those previously employed by him in solving the easier problem of modelling a crystal of the cubic system [Abs. 1189 (1915)]. Very full descriptions, with illustrative diagrams, are given, and the model is utilised for the consideration of the translational forces exerted upon some selected atom, which is found to be a far less simple problem than in the case of the cubic rock-salt crystal considered in the previous paper. The results obtained are confirmatory of the theory there developed, which makes the carbon atom consist of an outside ring of 8 and an inside ring of 4 electrons. The author mentions in a note that a considerable number of crystals in the isometric system has been worked out since the communication of his present paper, and experiment found to agree with theory. These include Zn and Cu. G. W. DE T.

1535. *Röntgen-ray Spectra.* **M. Siegbahn.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 10. No. 17. pp. 1–6, 1915. In Swedish.)—An investigation of the intensity distribution of Röntgen rays of different wave-lengths from an ordinary X-ray tube revealed two lines of very different intensities. Since these lines did not correspond with any of the characteristic lines of Pt, it was supposed that their origin lay in the antikathode. It was, indeed, found that these lines belonged to silver, and it was discovered subsequently that the antikathode consisted of platinised silver and that the Pt coating was appreciably damaged at the focus of the kathode rays.

The appearance of the two bands observed by de Broglie [Abs. 1837 (1914)], who employed a photographic method, depends on the varying sensitiveness of a silver bromide plate for waves shorter or longer than those of silver and bromine respectively.

By means of the results of Moseley's measurements [Abs. 467, 1249 (1914)], the author has calculated the values of the absorption by Al (μ/σ) for the kathode rays of 8 different elements. It is found that the relation between log (μ/σ) and log λ is linear, and that $\mu/\sigma = A\lambda^3$, the absorption being approximately proportional to the cube of the wave-length. T. H. P.

1536. *Experiments on Radio-active Emanations (Radium).* **A. Debierne.** (Ann. Physique [IX], 8. pp. 18–61, Jan.–Feb., 1915.)—The author explains the mode of preparation of RaEm and its chemical purification and the removal of H, O, N, CO_2, followed by fractional condensation. Even the product collected between −145° and −165° C. changed with time, showing a contraction, observed by Ramsay, of the bubble about 2·5 mm. in length, intercepted between mercury threads in a capillary tube. The emanation seems to undergo a spontaneous elimination of impurities. By γ-ray study it is found that the volume of emanation in equilibrium with 1 gm. of Ra is 0·58 $mm.^3$; the corrected value of 0·605 $mm.^3$ would agree with Rutherford (0·61) and Gray and Ramsay. The bubble mentioned is very strongly phosphorescent in leadless glass, and sparks are observed, apparently in the glass (which would be charged electrically by the particles) and sometimes in the gas. The examination of the spectrum agrees with Royds (1909). The decay constant was the same for different emanation fractions condensed at different temperatures. Attempts to accelerate the transformation by the aid of electric and magnetic fields proved useless. The total heat liberated by the decay is 185 gm. cals. per gm. of radium per hour; if 5 % of the total kinetic energy of the radiations be due to β-rays, then 19·5 % is due to α-rays, which would agree with other estimates. H. B.

1537. *Atomic Weight of Radio-active Emanations* (*Radium*). **A. Debierne.** (Ann. Physique [IX], 3. pp. 62–96, Jan.–Feb., 1915.)—The atomic weights deduced from previous determinations by the diffusion method had been much smaller than expected (Makower less than 100). As the partial pressure of the emanation, which has to be mixed with relatively very large volumes of some other gas in these experiments, was very small, it seemed doubtful whether the ordinary relation between density and rate of diffusion would hold. In the apparatus used for the new experiments the gas is made to pass through a very small orifice in a Pt diaphragm less than 0·01 mm. in thickness. The pressure on the one side of the diaphragm is a small fraction of a mm.; the other side is in continuous connection with a Gaede pump, at less than 0·0002 mm. Experiments were first made with oxygen, CO_2, SO_2, and argon at initial pressures p_0 of 0·001 to 0·075 mm. It resulted that the pressure p after time t was $p_0 = pe^{-\mu t}$, and that $M\mu^2$ (where M is the molecular weight) has the same value for each of the four gases. The relation for mixtures of gases (SO_2 and oxygen) is given by a more complex formula, and the rate of flow is not the same under strong and under weak pressures. Each gas behaves as if it were alone. For his calculations the author determines the ratio of the mean rate of flow to the mean velocity of the molecules, V/Ω, and arrives at results similar to those of Knudsen, but by a different method. The emanation, purified as mentioned in the preceding Abstract, is mixed with oxygen. From the density ratio 6·9 the atomic weight of 221 ± 2 is deduced for the emanation; this would approximately be the correct value if Ra = 226·4 and He = 4. The determinations of the atomic weight of the rapidly decaying emanations of Th and of Act required modified apparatus. For the emanation, Miss Leslie, working under the author in Curie's laboratory, finds a value (uncertain) of about 200, if monatomic. The author is experimenting with actinium emanations. H. B.

1538. *Distribution of Radio-elements in Rocks.* I. *Monazite Sand.* **M. Baltuch** and **G. Weissenberger.** (Zeits. Anorg. Chem. 88. pp. 88–102, 1914.)—Explains the general search for radio-activity and the separation of the different minerals. The magnetic field separates magnetite, ilmenite, and monazite; by the aid of centrifugal apparatus and heavy liquids quartz and felspar are then more or less separated from zircon and from one another. In this way monazite sand from Brazil is found to contain about 75 % of monazite, 12 of ilmenite, 9 of zircon, 3 of quartz, and magnetite and felspar in smaller quantities. The zircon isolated is violet (as if it had been submitted to radiations), and this colour is not removed by the hot concentrated sulphuric acid used for the better isolation of monazite. The amounts of Ra in gm. per gm. of mineral are: in monazite $1{\cdot}54 \times 10^{-10}$, in zircon $7{\cdot}88 \times 10^{-12}$, in ilmenite $8{\cdot}60 \times 10^{-13}$; the other minerals, quartz and felspar, contain less, the felspar only $2{\cdot}24 \times 10^{-15}$. The thorium contents (determined analytically) are: $4{\cdot}19 \times 10^{-2}$ in monazite, $1{\cdot}15 \times 10^{-5}$ in zircon, and $4{\cdot}89 \times 10^{-9}$ in felspar. The ratio Th/Ra is $8{\cdot}10 \times 10^{8}$ in monazite, $1{\cdot}51 \times 10^{6}$ in zircon, $1{\cdot}49 \times 10^{6}$ in magnetite, $1{\cdot}10 \times 10^{7}$ in ilmenite, $1{\cdot}94 \times 10^{6}$ in felspar, and $2{\cdot}08 \times 10^{6}$ in quartz. Uranium can chemically be estimated in monazite at about 0·068 %, the ratio Ra/U being $8{\cdot}22 \times 10^{-7}$. The mesothorium preparation from the sand contains 0·25 % of mesothorium, 25 % of Ra, and 75 % of Ba, all as bromides. Monazite itself is the richest of all these minerals. H. B.

1539. *Radio-activity of Spring Water.* **R. R. Ramsey.** (Am. J. Sci. 40. pp. 309–318, Sept., 1915.)—Observations of the emanation-content of a large number of springs in Ohio and Indiana have been made by Schmidt's "shaking method." In this method a known volume of water is shaken vigorously with a known volume of air for 2 mins.; the air is then pumped through the chamber of the electroscope until the emanation is thoroughly mixed with the air in the electroscope and the air in the shaking can. From a knowledge of the various volumes of air and water involved, and using a calibrated electroscope, the amount of emanation can easily be determined. The results obtained by this method are surprisingly consistent. A. B. W.

1540. *Volatilisation of extremely Thin Radio-active Deposits.* **A. B. Wood.** (Roy. Soc., Proc. 91. pp. 543–560, Sept. 1, 1915.)—Schrader's investigations on active deposits of actinium and thorium showed that volatilisation commences at a much lower temperature if the Pt-wire coated with the active deposit is first exposed to an atmosphere of chlorine [Abs. No. 1761 (1912)]. This author also advanced the view that, in consequence of the production of ozone by the *a*-particles, oxides are formed of the components of the active deposit. This explanation cleared up the divergence between the results of Russell [Abs. 1762 (1912)] and those of Makower [Abs. 1052 (1909)]. Similar results have been obtained by Barratt and Wood, and by Wood [Abs. 188, 468 (1915)]. The author's present investigations refer to some of the most important factors influencing the volatilisation of these exceedingly thin films; since thorium B gives a volatilisation curve which appears to be typical of that for any single constituent in the active deposits of Ra, Th, Act, it has been made use of in these experiments. As regards the surface for the deposition of the film, expense, oxidisability, etc., render various materials unsuitable, and Pt and quartz are the most convenient; owing to the ease of cleaning and manipulation, Pt is employed. The most consistent results are obtained when the Pt-foil is exposed to the emanation without electric field, the volatilisation in this case being practically independent of the time of exposure. The volatilisation is found to obey practically the same law as the rate of emission of positive ions from a hot body, this expression, rate $= AT^{n}\epsilon^{-b/T}$, being modified by the introduction of a factor, $\phi(N)$, which depends on the amount of active deposit that has been volatilised. This function $\phi(N)$ is considered from a physical standpoint, the mathematical relation being extremely complex. A comparison of the volatilisation curves at pressures of 760 mm. and 3 mm. has been made, a lowering of the initial temperature of volatilisation at low pressure being observed. The volatilisation curve at atmospheric pressure agrees very well with that given by Barratt and Wood (*loc. cit.*). T. H. P.

1541. *Radium Emanation in the Atmosphere.* **J. R. Wright and C. F. Smith.** (Terrest. Magn. 20. pp. 81–82, June, 1915.)—The measurements discussed in the paper were made by the charcoal method. In this method the emanation is absorbed from the air to be tested by coconut charcoal, from which it is afterwards driven off by heat and transferred to an ionisation chamber, where its effects are recorded in terms of the leak produced in an electroscope. The chamber is afterwards standardised by passing into it a known volume of RaEm, the latter being obtained by bubbling air through a cold standard solution of radium bromide. With reference to this method of standardisation the authors find that the amount of emanation carried over by the air from the bromide is not so great as has usually been taken in the past. They assume that the theoretical amount of emanation will be carried over when air is passed through boiling solution and thence deduce that with cold solution only 0·792 of this standard value is carried over. This figure is used in the work. Experiments were also made to test whether the charcoal itself contained any Ra as an impurity, but no evidence of such contamination was found. The paper contains the results of measurements of the RaEm content of the air at Manila. During a period of 8 months 21 determinations of the amount of RaEm per m.^{3} of air were made, the average value expressed in its radium equivalent being $82·5 \times 10^{-12}$ gm. The variations in the amount were considerable, the ratio of the maximum to the minimum being approximately as 4 to 1. Some observations were also made at an elevation of 2460 m. on Mount Pauai. The average value obtained here was 19×10^{-12}, or less than one-quarter of the value for Manila. This points to there being a considerable decrease in the quantity of RaEm with increase of altitude [see Abs. 1274 (1915)]. J. S. Di.

HEAT.

1542. *Variation with Temperature of the Coefficient of Expansion of Solids.* **S. Valentiner** and **J. Wallot.** (Ann. d. Physik, 46. 6. pp. 837–867, March 30, 1915.)—The modern molecular theory of solid bodies leads to a simple relation between the expansion coefficient, a, and the atomic heat, c_v [see Abs. 1114, 1507 (1908). The present paper forms a further investigation of this subject in which the actual measurements are made by a Fizeau-Pulfrich interference dilatometer. The values obtained for the expansion coefficients are considered to be correct to about 1 %. The low temperatures employed were attained by the use of liquid air and of a CO_2-alcohol freezing mixture. The solids investigated were Pt, Ir, Rh (measurements by W. Heraeus), invar, Si, fluorspar, and pyrites, and curves are given in the paper exhibiting the variations of a for these bodies between room temperature and about 100° abs. It is concluded that the value of a for the solids investigated is expressed to an approximation of ±1 or 2 % by a formula deduced from that of Nernst and Lindemann [see Abs. 1707 (1911)], viz., $a/a_\infty = (1/2)\{(\beta\nu/T)^2 e^{\beta\nu/T}/(e^{\beta\nu/T}-1)^2 + (\beta\nu/2T)^2 e^{\beta\nu/2T}/(e^{\beta\nu/2T}-1)^2\}$, where $\beta = 4{\cdot}786 \times 10^{-11}$, ν is the frequency of vibration of the atom at temperature T, and a_∞ is the coefficient of expansion at a very high temperature. The agreement between theory and experiment, however, appears not to be exact, and extrapolation by the formula, therefore, is considered to be less accurate than the use of curves drawn through the measured points. J. W. T. W.

1543. *The Mercury-resistance Thermometer. Resistance Change of Mercury between* 0° *and* 100°. **W. Jaeger** and **H. v. Steinwehr.** (Ann. d. Physik, 45. 7. pp. 1089–1108, Nov. 17, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—In continuation of former work [see Abs. 869 (1915)]. The fundamental divergence between two Hg-resistance thermometers in quartz envelopes is determined and then the departure from the thermodynamic temperature scale investigated. At 50° this amounts to $-2{\cdot}511$ deg., about 7 times as large as with the Pt-thermometer. The resistance-change of Hg between 0° and 100° is only about ¼th of that of the Pt-thermometer, so that the former is but little suited for thermometric measurements. It has, however, the advantage that the resistance need only be measured at a *single* normal temperature (*i.e.* 0°). L. H. W.

1544. *Specific Heat of Steam at Atmospheric Pressure between* 104° *and* 115° *C.* **J. H. Brinkworth.** (Roy. Soc., Phil. Trans. 215. pp. 383–433, Sept. 21, 1915.)—This paper is preceded by a lengthy preface (pp. 383–399) in which H. L. Callendar describes briefly some experiments made by him on this subject, using the continuous-flow method of calorimetry. The results obtained are summarised and are slightly higher than those deduced by extrapolation from the results of other observers, probably owing to the presence of a minute fraction (1 part in 10,000) of water present in the steam. The author thereupon undertook a redetermination of the specific heat near 100° C. by the same method but with the addition of numerous refinements and precautionary measures fully described in the paper. One of these is the Callendar pressure regulator for the automatic regulation of the steam pressure by the control of the gas supply to the boiler. Another is the "spiral" method of mixing the steam, in which use is made of a number of circular discs punched to fit the thermometer tube and then cut along a diameter, bent and soldered together to form a continuous spiral round the thermometer. This method of mixing is found to be a great improvement on the gauze method previously employed. The usual equation for the continuous-flow method is $E = SQd\theta + hd\theta$, where E is the electrical energy supplied, S the required specific heat, Q the rate of flow of the steam, $d\theta$ the rise of temperature of the steam, and $hd\theta$ is a term representing the heat loss. If this loss is independent of the flow, then a linear relationship exists between the values of $E/Qd\theta$ and $1/Q$. This is found not to be strictly the case, and another term depending on the flow is inserted in the fundamental equation which thereby becomes $E = SQd\theta + (h + k/Q)d\theta$. By the employment of three rates of flow, adjusting E in each case so that $d\theta$ remains the same, h and k can be eliminated and S measured. The value obtained for S is 0·484 cal. per gm. degree at 108° C. J. W. T. W.

1545. *Effect of High Ignition Voltages on the Accuracy of the Bomb Calorimeter.* **E. J. Dittus.** (Met. and Chem. Eng. 18. pp. 480–481, Aug., 1915.)—The ignition voltage employed in the determination of the calorific value of coal, oil, etc., by means of the bomb calorimeter, where an error of 0·2 % is permissible, need not be considered. It should, however, be taken into account when great accuracy is demanded. T. H. P.

1546. *Vapour Pressures of Halogen Hydrides and Hydrogen Sulphide.* **O. Maass** and **D. McIntosh.** (Roy. Soc. of Canada, Trans. 8. 8. Section IV. pp. 65–72, Sept., 1914.)—The determinations, at temperatures below the melting-point and between melting- and boiling-points, are made by the method and with the spiral glass manometer of F. M. G. Johnson, in which the corrosive gas comes in contact with glass only. No change in the curvature of the vapour-pressure curves was observed when the temperature passed through the melting-point. The observed melting-points are: HCl, —112°; HBr, —86°; H_2S, —83·8; HI, —50·6; and the boiling-points in the same order: —84·1 —66·8, —59·4, —35·6. All these values are in good agreement with Steele and McIntosh, Estericher (1896), Ladenburg and Krügel (1900). The latent heat of vaporisation is calculated after Clausius from the dP/dT; the observed (and calculated) values are: HCl, 14·9 (14·8); HBr, 17·8 (18·7); H_2S, 19·6 (19·5); HI, 18·6 (21·6), all in 10^{10} erg units. It was noticed that a paste of CO_2 snow and ether gives a remarkably constant temperature of —78·2° at atmospheric pressure. Hydrogen iodide, distilled *in vacuo*, solidifies to a glass which crystallises when slightly heated. H. B.

1547. *Specific Heat and Heat of Fusion of Ice.* **H. C. Dickinson** and **N. S. Osborne.** (Bureau of Standards [Sci. Papers, No. 248], Bull. 12. pp. 49–81, 1915.)—The full paper corresponding to Abs. 867 (1915).

1548. *Partition of Energy between Matter and Ether.* **L. Weisberg.** (Phys. Rev. 6. pp. 126–187, Aug., 1915.)—The author here attempts to show that equipartition of energy throughout the spectrum is not a necessary consequence of the classical mechanics. But he acknowledges that he is unable to offer a derivation of the sort of partition which would lead to Planck's formula. [See Abs. 841 (1912).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1549. *Electron Theory of the Hall-effect and Allied Phenomena.* **G. H. Livens.** (Phil. Mag. 30. pp. 526–548, Oct., 1915.)—A theory is propounded that provides an explanation of the observed phenomena both as regards the regularities and the irregularities. L. H. W.

1550. *Electron Theory of Metallic Conduction.* V. **G. H. Livens.** (Phil. Mag. 30. pp. 549–559, Oct., 1915.)—A further contribution of a mathematical nature [see Abs. 1444 (1915)].

1551. *Problems in Electrostatics and the Steady Flow of Electricity under the Exponential Potential e^{-kr}/r.* **C. E. Weatherburn.** (Phil. Mag. 30. pp. 568–581, Oct., 1915.)—Mathematical.

1552. *Energy of a Moving Electron.* **L. Page.** (Am. J. Sci. 40. pp. 115–128, Aug., 1915.)—In a previous paper it was shown that the equations of the electromagnetic field may be derived in their entirety from two fundamental assumptions, viz. :—(*a*) An ether exists which transmits strains in accordance with the postulate of the relativity of all systems moving with constant velocities. (*b*) The elementary charge is a centre of discrete, uniformly diverging, tubes of strain. [See Abs. 1797 (1914).]

The object of the present paper is to discuss and compare the expressions for the energy of a Lorentz electron moving with constant velocity as obtained by three distinct methods. The first of these methods consists in finding the electric and magnetic energies of the electron's field. The second consists in subjecting an electron which is at rest relative to the observer to an infinitesimal mechanical force for an infinite time. In this way a finite velocity is imparted to the electron without any finite radiation of energy. Hence the sum of the initial electrostatic energy of the electron, the work done by the mechanical force in accelerating the electron, and the work done by the ether pressure in producing the progressive contraction of the electron as its velocity relative to the observer increases, gives the energy of the moving electron. The third method is analogous to that used in finding the electrostatic energy of a charged conductor. Starting with an uncharged moving electron, an infinite number of shells of infinite radius are shrunk down to the surface of the electron. Each shell carries an infinitesimal charge and maintains throughout the process of contraction the same velocity as the electron. The sum of the work done in contracting the shells and that done in maintaining their constant velocity against the retardation of the field gives the energy of the charged electron. The value of the total energy must be independent of the method used.

The three methods are then taken in order. It is found that the work done in contracting the shells, or the potential energy of the electron, is equal to the electric energy of its field. The work done in maintaining the velocity of the contracting shells against the retardation of the field, or the kinetic energy of the electron, is found to be equal to the magnetic energy of the field, but to differ from the expression for the kinetic energy peculiar to Einstein's relativity dynamics. E. H. B.

DISCHARGE AND OSCILLATIONS.

1553. *Experiments on Ionised Gases.* **E. Salles.** (Ann. Physique [IX], 2. pp. 278–346, Oct., 1914.)—The diffusion-coefficients of the positive and negative ions of air and several gases, O, N, CO_2, H, are measured by two different methods. In the first series of experiments the Townsend method is used, the ratio of the mobility of the ions k to the coefficient of diffusion D being deduced from $k/D = Ne/P$, where N is the number of molecules per cm.^{3} and P the pressure. The apparatus of Townsend is modified so as to admit of working not only at atmospheric pressure, but also at higher pressures (up to 1800 mm.). The nature of the walls of the vessels, tubes of steel, German silver, brass, tin, had no influence on the diffusion-coefficient of the ions. In general the product DP proved constant; but in the case of the negative nitrogen ions this product had a higher value at the higher pressures. Hydrogen behaved exceptionally, owing probably to the impurities in the commercial hydrogen used; the ionisation observed was greater than in air, and the negative ions diffused much more rapidly than the positive ions; the presence in the hydrogen of gases from the lubricants, which themselves produce ionisation, might explain the discrepancy. In the second series the ratio k/D was directly determined by Langevin's method from the saturation curve of the gases under the influence of ionising agents. The results tend to show that the positive and the negative ions carry the same charges, and that, in the case of ionisation by γ-rays of radium at any rate, the ions carry one charge only, no multiple charges. H. B.

1554. *Charged Surface Layers formed on the Electrodes of Vacuum Tubes.* **K. T. Compton** and **L. W. Ross.** (Phys. Rev. 6. pp. 207–212, Sept., 1915.)—Seeliger [Abs. 960 (1914)] has found evidences of an electrical double layer, formed on the kathode of a Röntgen-ray bulb, which has the effect of changing the normal potential of the kathode by about 8 volts. Because of the frequent use in research of metallic films sputtered from kathodes and of metals which have been exposed to Röntgen ray discharges it is of practical importance as well as theoretical interest to understand the nature of this surface phenomenon, the cause of its erratic behaviour, and the methods by which it may be controlled. The apparatus employed is described in detail, and the results obtained are shown in tabular and graphical forms. The following are the chief conclusions arrived at:—The abnormal contact potentials produced on the electrodes by high-potential discharges are due to, and exist in, insulating films such as wax or grease on the surfaces of the electrodes and are reduced or eliminated by shielding or by avoiding all such substances. On insulating films of small viscosity, surface charges are produced by convection currents in the film set up by the applied field, even though this field may be too small to produce a vacuum discharge. During a vacuum discharge a charged layer of gaseous ions is deposited on the surface of the insulating film. This charge is of a sign opposite to that of the potential of the electrode during the discharge, and is therefore opposite to that produced by convection currents. The apparent contact p.d. is the resultant of these two effects, whose relative importance depends on the viscosity of the film and the nature of the discharge. A. E. G.

1555. *Control of Electric Spark Discharge.* **W. O. Sawtelle.** (Astrophys. J. 42. pp. 168–171, Sept., 1915.)—As a preliminary to a spectroscopic study of the electric spark a method of controlling the discharge has been devised,

enabling the observer to superpose a succession of images on the slit with such accuracy that any particular phase of the oscillations may be examined. Previous investigators have endeavoured to do this by mechanical means of control [Abs. 855 (1904)], but it was not thereby possible to determine the time variation between discharges nearer than a few thousandths of a second. The necessary degree of control has now been satisfactorily obtained by the ionisation produced by a beam of ultra-violet light projected from a rotating mirror on the negative terminal of a spark-gap in series with the principal gap. The source of ultra-violet radiation was a Fe-Mg arc with a gap of about 0·5 mm., using 500 volts. Interesting results were found in the photographs of the spectrum of the cadmium spark under the new conditions, differentiations being decided between the lines showing oscillation, such as λλ5379, 5338 (shown together because of small dispersion), and others giving continuous radiation, as λλ4676, 4800, 5059, which persist after the oscillations have died out, brighter in the middle of the gap than near the terminals.
C. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1556. *Electric Conductivity of Pure Liquids.* **J. Carvallo.** (Ann. Physique [IX], 1. pp. 171–225, Feb., and 2. pp. 142–225, Aug., 1914.)—The research concerns the questions whether pure liquids such as liquefied ammonia, sulphur dioxide, acetone, hydrocyanic and hydroiodic acids, alcohols, hydrocarbons, etc., have a limiting conductivity like water, and whether this limit can be attained, in the chemically purified solvents, by the aid of electrolysis. In the case of liquid SO_2 the continuous current passing decreases rapidly, and seems to tend to a limit, so that Warburg spoke of an electrolytic purification. But there is also decomposition by the high voltage (5700 volts in some experiments with electrodes 2 mm. apart). There is generally a decrease of conductivity on continued electrolysis; ethyl alcohol showed an increase, methyl alcohol was not affected, and acetone and SO_2 gave varying results. The lower limits found are mostly smaller than those of previous observers: sulphur dioxide at 15°, $1·8 \times 10^{-11}$; ammonia at 15°, $8·8 \times 10^{-10}$, at —80°, $4·9 \times 10^{-10}$; ethyl ether at 16°, $7·6 \times 10^{-16}$; acetone at 15°, $1·2 \times 10^{-10}$; ethyl alcohol at 17°, $0·9 \times 10^{-8}$; methyl alcohol between 0 and —20°, $8·0 \times 10^{-7}$; hydrocyanic acid at 0°, $1·1 \times 10^{-7}$. A limiting conductivity, independent of the field, cannot, however, be a criterion of chemical purity, since it has also been observed in liquids containing traces of impurity. Most of the liquids studied seem to resemble gases as regards conductivity, and would not have any measurable conductivity in the pure state.

The second paper deals particularly with the effect of light, all the experiments having been made in a closed room, lighted by one glow-lamp, whilst in one experiment the cell had been near the open window exposed to sunlight. The behaviour of SO_2 under insolation was hence studied. On every exposure to light the current diminished abruptly, but rose very gradually under continued illumination. Light thus has a positive and a negative effect, the latter of which is not understood; the light decomposes the SO_2, and some of the products are photoelectrically sensitive. The investigation is being continued. [See also Abs. 1490 (1913).]
H. B.

1557. *Dielectric Constants of Gases.* **L. Verain.** (Ann. Physique [IX], 1. pp. 255–296, March, and pp. 523–590, June, 1914.)—Measurements of the dielectric constants k of air, CO_2, and SO_2 are made by two methods. By the first method (a modification of Lebedew's as regards the electric arrangements) the capacity of a cylindrical condenser (which is first evacuated and then filled with the gas) is compared with the capacity of a variable condenser, at temperatures between 0° and 70°, and pressures up to 6·5 atmos. (in the case of SO_2 only to 2·4 atmos.). As regards air, Maxwell's $k = n^2$ (refractive index) is well confirmed; the accord for CO_2 and SO_2 is not satisfactory. Both air and CO_2 fulfil the Mossotti-Clausius relation $(k-1)/(k+2)d =$ constant ($d =$ density); again SO_2 deviates considerably.

In the second paper the method of Drude (electric oscillations) is used for determining the value of k for liquefied and gaseous CO_2 between temperatures $-4°$ and $+81·4°$ (the critical temperature). At the critical point the dielectric constant shows a continuous variation, the tangent to the curve plotting k against temperature becoming perpendicular to the temperature axis at that temperature. The density appears in accord with the Mossotti-Clausius formula, also when studied by his method; but again SO_2 shows a much less satisfactory agreement. H. B.

1558. *Influence of Weight and Dimensions of Hammerhead and Spring on the Efficiency of an Interrupter.* **W. B. v. Czudnochowski.** (Deutsch. Phys. Gesell., Verh. 17. 15. pp. 305–314, Aug. 15, 1915.)—In the case of the ordinary interrupter consisting of a hammerhead attached to the end of a spring, let a be the length of the spring from its fixed end to the make-and-break point, and b the length from this point to the centre of gravity of the hammerhead. Then if a/b is too great the duration of current flow is too short, while if this ratio is too small the duration of break is too short and the separation too small. Further, if the hammerhead is too light the arc of swing is too small and the duration of break again too short, while if too heavy the time of oscillation is too great and the speed of break therefore too slow. In an actual experiment the author found that by quadrupling the weight the sparking distance of a coil was increased from 15 to 26 mm.

J. W. T. W.

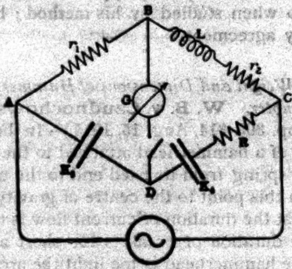
1559. *A.C. Resistance of Short Coils.* **C. W. Oseen.** (Ark. f. Mat., Astron. och Fysik, Stockholm, 9. 27. pp. 1–21, 1914.)—W. Lenz [Abs. 1261 (1912)] has applied Sommerfeld's method to the calculation of current distribution in long coils. The resistance of short coils has been investigated experimentally by R. Lindemann and W. Hüter [Abs. 1195 (1913)]. The author examines this case theoretically and is unable to confirm the theoretical explanations offered by these investigators for their results. The paper is entirely mathematical and should be referred to in the original.

W. H. G.

1560. *Thermoelectric Power and Mechanical Strain.* **W. P. White.** (Phys. Rev. 6. pp. 234–236, Sept., 1915. Abstract of paper read before the Amer. Phys. Soc., April, 1915.)—In general the effect of alloying a metal is to lower the thermoelectric power. The effect of hardening by permanent strain (bending, drawing through dies, etc.) either a pure metal or an alloy is to *raise* the power. Hence hardening has an opposite effect to alloying, though of less amount. Platinum alloys, however, are most of them higher than Pt, and the alloy of Pt containing 10% of Rh is lowered by mechanical hardening, so that here also alloying and hardening have effects opposite to each other. Pure Pt, however, is changed in the same direction by hardening and (usually) by alloying.

Two portions of constantan wire, hardened by drawing, were annealed, one at 800° and the other at 800°. The latter was not so soft mechanically yet was as low thermoelectrically as the other ! E. H. B.

1561. *Alternating-current Bridge.* **D. Owen.** (Electrician, 75. pp. 680–682, July 30, 1915.)—For the measurement of self-induction (L) with this bridge a standard of capacity (K_3) is employed. The current in the detector branch BD is zero provided $K_3r_1 = K_4r_2$ and $L = K_3r_1R$. Balance is attained by the alternate adjustment of r_2 and R. The required inductance is given by $L = K_3r_1R$. Balance is independent of frequency and wave-form, the bridge having high sensibility over the range 100 ∾ to 1000 ∾.



Residual effects due to the condensers possessing resistance and the resistances inductance, may be eliminated by substituting a non-inductive resistance for L. If R_0 be the new value for R the true value of L is $K_3r_1 (R - R_0)$. K_3 and K_4 should be mica condensers, ½ mfd. being suitable. r_1 may be 1, 10, 100, . . . ohms, according to the value of L. r_2 may be a resistance box in series with a carbon plate rheostat, and R a graduated loop of manganin. A telephone is the more sensitive detector for low inductances, and a vibration galvanometer if the coil contains iron. Examples of measurements are given, ranging from 2 microhenrys to 0·1 henry. On account of the large capacities employed, errors due to earth capacities are avoided. The bridge can also be used to determine effective resistances and capacities. For proofs of formulæ, etc., reference is made to Phys. Soc. Proc. p. 39, 1914. W. H. G.

1562. *Ballistic Moving-coil Galvanometer on prolonged Discharges.* **A. G. Worthing.** (Phys. Rev. 6. pp. 165–179, Sept., 1915.)—The author has developed and tested a theory by means of which a correction factor is obtained for the case of the exponentially decaying discharge, giving the ratio of the deflection for an impulsive discharge to the deflection for the prolonged discharge of the same quantity. This correction factor is given in terms of the logarithmic decrement, the period of the galvanometer and the time taken to reach the max. deflection. The tests showed that the assumptions made in the theory were justified, namely, that the effect of the self-inductance in the galvanometer circuit under ordinary conditions is negligible and that the apparent resistance agrees exactly with the real resistance. The method used was based on Corbino's method of measuring the thermal capacity of filaments at high temperatures [Abs. 1068 (1912)] in which on varying the resistance in series with two filaments forming the arms of a bridge a discharge of the exponentially decaying type passes through the galvanometer circuit. A method for determining the time-constant of the exponentially decaying discharge, by means of observations with galvanometers of different periods is also given. W. H. G.

1563. *The Electrodynamometer in the Modern Laboratory.* **A. Barbagelata.** (Elettrotecnica, 2. pp. 594–608, Sept. 15, 1915.)—The author observes that the electrodynamometer is the most general apparatus for electrical measurements. It allows of the determination of resistance, inductance, capacity, phase, voltage, power, etc. The determinations of the said quantities are obtained by zero methods. An excitation current I_f is sent through the fixed coils. The current through the movable coil I_m, of the same frequency, is obtained in different ways according to the quantities to be measured. The zero in the apparatus can be obtained either by reducing I_m to zero or by producing quadrature between the two currents. Hence the two classes of methods: the *method of zero current* and the *method of projection.* The shifting of the phase in this latter method is obtained by a phase-shifting apparatus acting upon the excitation current.

The Wheatstone and Thomson bridges for alternating and continuous currents, the Matthiessen method for measuring small resistances, the potentiometer, etc., are particular cases of the one or the other of these methods. It is especially worthy of note that with a bridge arrangement it is possible to measure extremely small inductances. The author gives examples and schemes for the measurement of several of these quantities.

The electrodynamometer actually used is formed of a small movable coil enclosed in a flat glass or celluloid box, a mirror and a sheet of mica being stuck to it for the purpose of obtaining a good air damping. The two fixed coils cover parts of the box. The movable coil is suspended from a small metallic strip, which serves both to lead the current and to give the antagonistic force. Another similar strip, which is left loose, serves as second leading-in conductor. Photographs of the apparatus are given.

E. B.

1564. *The Kathode-ray Tube and its Application.* **M. E. Tressler.** (Gen. El. Rev. 18. pp. 816–820, Aug., 1915.)—A simple description of the construction and theory of operation of some of the more successful kathode-ray tubes. The author also describes the use of such tubes as oscillographs and wattmeters for measuring very small amounts of power at low power-factors and high voltages. T. H.

1565. *Induction Balance for Determining the Presence of Shells in Agricultural Land.* **C. Gutton.** (Comptes Rendus, 161. pp. 71–73, July 26, 1915.)—The apparatus here described, which indicates the presence of a shell of small calibre at depths up to 40 cm., has become a necessity on account of accidents which have already resulted by unexpected contact of ploughshares and other agricultural implements with unexploded shells embedded in the soil. The distance from the coil to the objects under investigation, and the large surfaces which must be explored make it essential that the coils employed should be of large diameter. Those used have a diam. of 70 cm. The coils of the primary circuit have 20 turns and those of the secondary 10 turns. The distance between the primary and secondary coils is modified in the absence of all metallic masses until silence in the telephone indicates that the mutual induction of the two circuits is nil. In order to make more perfect and easy the regulation, a small coil of 4 turns is added to each circuit. The diam. of one of these coils is slightly smaller than that of the other, and so the former is able to turn inside the latter on a common diameter. This rotation modifies the mutual induction of the two circuits and enables a rapid regulation of the apparatus to be made. The desired sensitivity has been obtained by employing suitable telephones and, above all, by making use of periodic currents of suitable form in the primary circuit. The method of obtaining a suitable primary current is described in detail, as is also the manner of exploring land for buried shells. It is stated that two persons used to the work can investigate a hectare [100 m. × 100 m.] in about 3 hours by this method. A. E. G.

ALTERNATING CURRENTS AND MAGNETISM.

1566. *Magnetic Habits of Alloy Steels.* **J. A. Mathews.** (Am. Soc. for Testing Materials, Proc. 14 [17 pp.], 1914.)—The author puts forward a plea for the adoption of a factor that he believes is of considerable value in judging of magnetic quality in hardened steels. This quality factor is the ratio B_r/H_c, where B_r is the residual induction and H_c the coercive force. Above $H = 200$ this ratio becomes nearly constant, so that comparative tests can be made at different values of H. Actually the inverse of this ratio is preferred since this would give increasing values for increasing permeance, but as this would give decimal values B_r is expressed in kilogauss. In such case, for a steel showing $B_r = 12{,}000$ and $H_c = 60$, $B_r/H_c = 200$, or $H_c/B_r = 5$. Another steel of the same residual induction and $H_c = 72$ would give $H_c/B_r = 6$: a higher quality factor because of higher permanence in proportion to B_r. The experimental part of the work was carried out with an Esterline permeameter. The product of a single ingot was taken and rolled into bars of different cross-sections, the pieces being then hardened and finally tested in bar form. It was found that B and B_r both increased as the size decreased, while the ratio B_r/H_c showed the largest section to be the most permanent. This is contrary to experience in the making of horseshoe magnets. The effect of oil hardening and water hardening is shown by the results given in the original. Retarded rates of cooling, it is found, lessen the ultimate hardness, and in many steels this results in decreased $B_{max.}$ and B_r and in increased permanence. Drawing the temper also relieves the hardness, but in this case the results magnetically are contrary to those due to the retarded quenching rates.

The tabulated results must be referred to for a more complete understanding of the author's paper. L. H. W.

1567. *Application of a General Electromagnetic Theorem to the Magnetic State of a Twisted Iron Bar.* **G. J. Elias.** (K. Akad. Amsterdam, Proc. 18. pp. 827–846, Sept. 8, 1915.)—In a magnetic field in which the induction is an arbitrary vector function of the force, variable from point to point, and the media in the field may be anisotropic with respect to conductivity but in which no phenomena of hysteresis occur the magnetic field energy is $T = 1/c \int \Sigma i \, . \, dM$, where i is the current in the circuit, M the induction flux, and c the ratio of the electromagnetic to the electrostatic unit of quantity. Starting with this the author investigates mathematically the following cases:

(1) the production of circular magnetisation in a longitudinally magnetised iron rod when subjected to torque; (2) the production of longitudinal magnetisation when the bar is circularly magnetised and subjected to torque; (3) the twist which appears when the bar is subjected to simultaneous longitudinal and circular magnetisation. L. L.

1568. *Magnetisability of the Oxides of Manganese, Chromium, Uranium Molybdenum, and Tungsten.* **E. Wedekind** and **C. Horst.** (Deutsch. Chem. Gesell., Ber. 48. pp. 105–112, Feb. 6, 1915.)—In compounds of titanium and vanadium, in which these metals have a definite valency, the magnetic susceptibility increases as the valency decreases [see Abs. 751 (1912), 847 (1914)] and this holds also for the oxygen and partly for the sulphur compound of Mn and Cr. The mixed oxide Mn_3O_4 is most magnetic like Fe_3O_4 and Ti_3O_5; the monoxide of Mn is more magnetic than the dioxide. Chromium trioxide CrO_3 is less magnetic than Cr_2O_3, whilst Cr_5O_9 and Cr_4O_9 which have salt character are 8000 times more magnetic than the former oxides. Of the sulphides Cr_3S_4 is most magnetic. In these respects chromium shows analogies only with the elements near it in the horizontal group of the periodic table, not with the elements in the same vertical group. Thus, in distinction from Cr, the elements uranium, molybdenum, and tungsten do not show any latent magnetism. The di- and trioxides of U are more magnetic than the metal, and the mixed oxide U_3O_8 is not strongly magnetic. The modes of preparation of some compounds, manganates and permanganates of Ba and K, and chromium sulphides, are described. H. B.

1569. *Magnetic Susceptibility and Number of Magnetons of Nickel in Solutions of Nickel Salts.* **P. Weiss** and **E. D. Bruins.** (K. Akad. Amsterdam, Proc. 18. pp. 246–253, Sept. 8, 1915.)—The dependence of the magnetic susceptibility of nickel in solutions of its salts on the concentration has been investigated by Piccard's modification of Quincke's method [Abs. 518 (1913)], Piccard's value for water at 20°, namely $\chi = -0{\cdot}7193 \times 10^{-6}$ being taken. The results obtained with aqueous solutions of nickel sulphate, chloride, and nitrate of different concentrations give for $\chi^0_{Ni} \times 10^6$ the values 445·1, 444·8, and 445·4 respectively and for the number of magnetons *n* in the Ni atom 16·06, 16·05, and 16·06. Thus, within the limits of experimental accuracy, the value of χ^0_N at 20° and also the number of magnetons seem to be independent of the nature of the salt and of the concentration of the solution. This result agrees with that obtained by Cabrera, Moles, and Guzman [Abs. 1339 (1914)], who found the values 16·07, 16·03, and 16·02 for *n*. The number of magnetons of Ni in dissolved nickel salts seems, therefore, to be a whole number and supports the magneton theory.

Ammoniacal solutions of nickel salts were also investigated, the measurements being made in an atmosphere of hydrogen and ammonia in order to prevent evaporation of the ammonia, and the results corrected for the susceptibilities of the water and the ammonia. The values obtained with different concentrations of ammonia show that $_{NH_3}$ is constant, irrespective of whether the ammonia is bound to the nickel salt or free in the solution; the susceptibility may, therefore, be assumed to be an additive property and the correction may be deduced from the total amount of ammonia present. With these solutions the values of χ_{Ni} at 20° are smaller than in absence of ammonia, and the same is the case with the number of magnetons, which are found to be 15·59, 15·57, and 15·57 for the sulphate, chloride, and nitrate respectively. Addition, either of sulphuric acid to aqueous nickel sulphate, or of ammonium sulphate to ammoniacal nickel sulphate is without influence on the number of magnetons.

Measurements with aqueous nickel chloride at 6°, 16·7°, and 80·7°, and with ammoniacal nickel chloride at 6·7°, 18·6°, 20·2°, and 56·2° give, for each solution, constant values for the product of χ^{a}_{Ni} with the absolute temperature, Curie's law being thus obeyed. T. H. P.

1570. *Magneto-chemical Researches on Ferrous Salts in Solution.* **P. Weiss** and **C. A. Frankamp.** (K. Akad. Amsterdam, Proc. 18. pp. 254–258, Sept. 8, 1915.)—The salts investigated were ferrous sulphate and ferrous ammonium sulphate, the solutions being prepared by means of boiled water and the measurements carried out in an atmosphere of hydrogen. From the results obtained by Cabrera and Moles [Abs. 1519 (1913)] with ferric salts, variation of the number of magnetons with the concentration might be expected in the case of ferrous salts. The results show, however, absolute constancy in this respect. With low concentrations slight variations—between 26 and 27—from the average value, 26·49, are, indeed, found, but these are shown to be due to hydrolysis of the salts and are prevented by addition of sulphuric acid. Attempts to enhance the hydrolysis by addition of traces of sodium hydroxide resulted in the formation of a fine, granular precipitate and thus interfered with the measurements. T. H. P.

1571. *"H" determined by Discharge from Wehnell Kathode.* **C. T. Knipp** and **L. A. Welo.** (Terrest. Magn. 20. pp. 53–68, June, 1915.)—An experimental research, of which the following is a summary :—(1) A new method of determining H is here developed depending on the property of kathode rays of being deflected by a magnetic and an electrostatic field. The ratio *e/m* is assumed as 1·765 × 10^7. (2) A modified form of Braun tube was used, equipped with the Wehnelt hot-lime kathode adjustable in position, and deflections were recorded on a photographic plate. (3) The difficulty of eliminating the earth's magnetic field for a zero reading of deflection was avoided by mounting the tube in a frame free to turn about a vertical axis. A second difficulty in connection with the breaking down of the deflecting electrostatic field, owing to ionisation of the residual gas, was overcome by the use of an alternating e.m.f. (4) A method of correcting for irregularities at the ends of the electrostatic field plates was devised and the equation of motion integrated graphically. (5) Ten determinations of H were made and the relative probable error is in the fourth significant place. The agreement among individual determinations is of the same order as that among the best determinations of the ratio *e/m* with kathode tubes. (6) The method shows that it is practicable to use the known earth's magnetic field for deflecting purposes when measuring *e/m*. E. H. B.

1572. *Theories regarding Magnetism.* **R. Jouaust.** (Lum. Élec. 30. pp. 289–297, Sept. 25, 1915.)—A summary of present views regarding the different theories that have been put forward. L. H. W.

1573. *Analytical Expressions for the Intensity of a Magnetic Field due to a Current Flowing in a Circular Wire.* **O. Billieux.** (Lum. Élec. 30. pp. 145–149, Aug. 14, and pp. 169–172, Aug. 21, 1915.)—A mathematical paper, which cannot be usefully abstracted, giving expressions for the intensity of the magnetic field at any point due to solenoidal currents. J. W. T. W.

1574. *Magnetic and Electric Observations during Solar Eclipse.* 1914 *August* 21. **C. Chree.** (Terrest. Magn. 20. pp. 71–74, June, 1915.)—Special observations were made at Kew relative to the solar eclipse of 1914 Aug. 21, and adjacent days, to secure records of magnetic variations, positive ionisation, air-earth currents, and potential gradient. Tables are given of the values obtained. On the day of the eclipse there was a slight lag in the westerly movement in declination during the time of eclipse, but a very similar and slightly larger effect of the same kind occurred at about the same hour on the previous day. C. P. B.

1575. *Secular Change in the British Isles,* 1892–1913. **C. Chree.** (Terrest. Magn. 20. pp. 49–51, March, 1915.)—This paper contains a short account of the secular change of the magnetic elements in the British Isles, these having altered so much of late years, *e.g.* in 1901 it almost looked as if the needle were about to retrace its path to the west, and as the secular change of D began to accelerate that of H and I suddenly fell off. In the case of D, where instrumental changes are least likely, the results from different stations are remarkably similar. The mean results suggest that H is now falling, and at a gradually accelerating rate; until about 1900, H was rising all over the continent, but then passed a maximum, began to fall in the east of Europe, and the area within which the secular change is a reduction has rapidly extended westwards. The paper concludes with a short notice of E. Leyst's view that the secular change of declination is largely dependent on sun-spot conditions at the time. H. H. Ho.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1576. *Localisation of Projectiles by Radiography.* **A. Gascard** and **E. Beignot-Devalmont.** (Comptes Rendus, 161. pp. 129–131, Aug. 9, 1915.)—The following advantages are claimed for the method here described, in which either two marks or a cross are used on either side of the patient. It requires only a diagram in which it is necessary to join points 15 cm. apart at the most. Depths can be calculated by a formula previously given. Very great freedom is allowed to the radiographer, who can always place the wounded so that the projectile is as near as possible to the plate, and thus two easily visible shadows are obtained. The displacement of the tube may be made in any desired direction. The manipulations are reduced to a minimum, and the results obtained are absolutely exact. A. E. G.

1577. *An Electro-vibrator worked with Interrupted Currents.* **E. F. Perreau.** (Comptes Rendus, 161. pp. 206–209, Aug. 23, 1915.)—In employing continuous currents with the electro-vibrator when searching for fragments of shell in the human body, a rotating interrupter is used in the circuit. The vibrations so produced are more intense than those obtained with alternating current, and, instead of a continuous tremor, take on the form of periodic shocks. Graphs obtained with a Marey tambour show this very plainly. The intensity of these shocks is often sufficient to produce a visible movement of the skin. The action with non-magnetic bodies is also greater with continuous currents. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1578. *Experiments on the Production of Helium.* **A. Debierne.** (Ann. Physique [IX], 2. pp. 478–488, Nov.–Dec., 1914.)—This paper deals with some experiments on the production of helium by other than radio-active agencies. Certain dark-violet fluorspars (almost black sometimes) smell of ozone. When they are heated, they lose their colour and also their former thermo-luminescence. All these specimens yield helium on heating, in very variable but always small quantities (from a few tenths of a mm.^{3} to 50 mm.^{3}). On exposing such a specimen, which had apparently given up all its helium, to radium rays, it turned violet again, and renewed heating then once more revealed the helium spectrum; but a second test of this kind did not give helium once more. In other experiments electrolytic gas was continuously being burnt for days, without explosions, by being kept in contact with heated copper and copper oxide; not a trace of helium was ever found in this gas, nor in electrolytic gas produced by decomposing water by radium rays. In other experiments the disruptive discharge of a mercury-arc was continuously sent through the vapour; the mercury in the one end of the glass tube was in constant communication with a mercury reservoir to maintain constant conditions for days. No helium was ever found; nor was any discovered when oxygen was introduced into the apparatus, and the arc worked again.
H. B.

1579. *Gases produced by Radio-active Substances. Decomposition of Water.* **A. Debierne.** (Ann. Physique [IX], 2. pp. 97–127, Aug., 1914.)—Reviewing the literature on the subject the author concludes that all the three kinds of rays, α, β, γ, participate in effecting decomposition, and that the decomposition takes place in three ways: by direct collision of the charged particles with the molecules of water; by the local rise of temperature along the path of a particle; by the secondary electrolytic phenomena due to the ionisation, which are important even with α-rays. The interaction of the ions, which are designated $\overset{+}{H}_2O$ and $\overset{-}{H}_2O$, with the ions in the water (hydrogen and hydroxyl) liberates hydrogen, hydrogen peroxide, and oxygen. The relative share of the different particles and the importance of the several reactions are not certain; β-rays, however, give nearly pure hydrogen. In the author's new experiments the radium salt was enclosed in a thin-walled glass bottle and placed within the cavity of the U-shaped glass cell so that the rays had to traverse two glass thicknesses before reaching the water in the cell. Assuming that the number of ions formed in the water is the same as would be produced in a gas, the calculated and observed rates of decomposition are of the same order. H. B.

1580. *Properties of Elements and the Periodic System.* **N. Dhar.** (K. Akad. Amsterdam, Proc. 18. pp. 884–898, Sept. 8, 1915.)—It has been shown previously (Zeits. Elektrochem. 19. p. 911, 1913) that the heats of ionisation of elements and the temperature coefficients of the mobility of the ions are periodic functions of their atomic weights. The following further properties are now considered.

(1) *Surface tension.*—The specific cohesions of the elements, plotted

against the atomic weights as abscissæ, give well-defined periodic curves, the alkali metals lying on the topmost points, whilst Zn, Cd, and Hg lie on a straight line on the descending portions of the curve, and P, As, Sb, and Bi occupy similar positions at the minima. (2) *Temperature coefficients of electrical conductivity* also give a periodic curve resembling that obtained with the temperature coefficient of ionic velocities (*loc. cit.*), elements of one and the same group lying very nearly on a straight line and occupying analogous positions on the curve; the alkali metals are situate at the maxima. (3) *Temperature coefficients of thermal conductivity* are available for comparatively few elements, but periodicity seems probable. (4) *Torsional rigidity, Young's modulus, and their temperature coefficients.*—In the same periodic group, the torsional rigidity and Young's modulus increase with the atomic weight. In the sub-group Cu, Ag, Au, the last has the highest atomic weight and the lowest values for Young's modulus and the torsional rigidity; the same holds with Zn, Cd, Sn, and Pb. The temperature coefficient of torsional rigidity forms distinctly periodic curves, the alkali metals occupying the maxima and Cu, Ag, and Au, lying on a straight line through the minima. (5) *Specific heat.*—The non-periodicity of the specific heat-atomic weight curve is unique. The values obtained by Dewar for the specific heats at about 50° abs. form, however, a periodic curve, the alkali metals being at the maxima and the platinum metals at the minima. (6) *Coefficients of linear expansion* are also periodic functions of the atomic weights; the alkali metals occupy the maxima of the curve, whilst S, Se, and Te lie on a straight line on the ascending portions of the curve. Cu, Ag, and Au occupy similar positions at the minima, as also do As, Sb, and Bi. (7) *Molecular magnetic rotations* form a distinctly periodic curve, the halogens occupying the topmost points. T. H. P.

1581. *Electric Conductivity of Air in Contact with Phosphorus.* **R. Schenck** and **E. Breuning.** (Deutsch. Chem. Gesell., Ber. 47. pp. 2601–2611, Sept. 26, 1914.)—The authors confirm their previous conclusion that the ionisation of air which has been in contact with phosphorus is due to the interaction between the sesquioxide P_4O_6 and water, but only indirectly. This reaction gives rise to a decomposition of a very complex character, yielding phosphorous acid, phosphoric acid, phosphorus hydrides (one solid yellow hydride $P_{12}H_6$ was always observed in very small quantities), and further a vapour of unknown nature, called "phosphorus emanation," which is completely condensed at −180°, but has even at −80° an appreciable vapour-pressure. This emanation was prepared by letting P_4O_6 and water-vapour react in a current of nitrogen. At ordinary temperature the emanation evaporates at once and discharges an electrometer. H. B.

1582. *Mechanism of the Chemical Action of Electric Discharges through Gases.* I. *General Considerations.* **E. Briner.** (J. Chimie Physique, 12. pp. 526–533, Oct., 1914.)—The chemical activity of the electron discharge may be thermal, electronic, or photochemical. The relative proportions of these three factors have hardly been investigated; in how far electrons take part in chemical phenomena is not known. The author therefore studied certain reactions. II. *Formation of Ammonia.* **E. Briner** and **J. Kahn.** (Ibid. pp. 534–563, Oct. 1914.)—Mixtures of nitrogen and hydrogen in the ratio $N_2 : 3H_2$ are submitted to three kinds of discharges. In two of the three cases a spark-gap of two Pt-wires is used. For the spark discharge the wires are joined to the secondary of an induction coil, the primary of which is fed with alternating current at 110 volts and 47 ∼ through a Wehnelt interrupter, giving about 1000 sparks per sec. For the arc discharge the Wehnelt is cut out; for the glow discharge an ozone apparatus is used, coupled to the same coil without interrupter. At constant temperature and varying pressure the yield of ammonia attains a maximum (spark and arc) at about 100 mm.; observations are more difficult with the glow discharge, because the yield then is much smaller, but the pressure influence is different, the yield decreasing first as the pressure is lowered, and then rising rapidly to a maximum of 100 mm. again. The temperature was varied between $-85°$ and $+500°$; most nitrogen was bound at 300°, least at 100°. Increase in current intensity favoured combination without any regularity; the spark-gap width had little influence at 100 mm. pressure. Increase in the volume of the bulb does not favour combination. III. *Rôle of Ionisation.* **E. Briner.** (Ibid. 13. pp. 18–32, March, 1915.)—In accordance with Davies (1908) the author finds that the final state resulting in the discharge through mixtures of nitrogen and hydrogen, and also of nitrogen and oxygen, is the same as when the discharge is sent through NH_3 or NO. The addition of auxiliary electrodes, for the purpose of varying the electric conditions of discharge, also had very little influence. These auxiliary electrodes were either a pair of Pt-foils, 1 cm.^{2} surface each, fixed vertically, 1 cm. apart, about 4 cm. below the spark-gap in a cylindrical bulb about 10 cm. long, or a disc of Pt, 1 cm. in diam., fixed close below the spark-gap. The reacting elements are assumed to be thermally dissociated atoms of N, H, or O, and the combinations due to the discharge are considered to be essentially thermal in nature. The photochemical effect does not enter, since ultraviolet light only destroys the product formed. H. B.

1583. *Cerium-Magnesium Alloys.* **R. Vogel.** (Zeits. Anorg. Chem. 91. pp. 277–298, April 6, 1915.)—Whilst cerium combines with Al, Si, Sn, Pb, Bi, under liberation of a considerable amount of heat, the combination with Mg absorbs heat; all the Ce-Mg alloys are liquid at 800°, and they may be heated in carbon vessels as there is little tendency to carbide formation. The chemical compounds Ce_4Mg, CeMg, $CeMg_3$, $CeMg_9$ are analogous only to KHg, KHg_2, KHg_9. The Ce_4Mg breaks up into CeMg and Ce at 497°. These two compounds, low in Mg, are pyrophoric, the others, containing more than 22 % by weight of Mg, are not; CeMg is hard, oxidises on heating, keeps fairly well in moist air, but explodes in a Bunsen flame when containing Mg in solid solution. $CeMg_9$ is softer, brittle, and crumbles. All these compounds of Ce with Mg being comparatively loose, whilst those with the other elements above mentioned are much more stable, the author suggests that cerium is to be grouped rather with Mg than with Al, Si, etc. H. B.

1584. *Thermochemistry of Compounds of Copper and Aluminium.* **L. Rolla.** (N. Cimento, 9. pp. 382–387, May–June, 1915.)—Determinations of the specific heats of various intermetallic compounds carried out by Schimpff and by Schübel [Abs. 1118 (1910), 1068 (1915)] seem to prove that deviations from Neumann and Kopp's law cannot be attributed either to the heat of formation or to the position of the compound on the melting-point curve. Of these compounds, the author considers Cu_3Al, CuAl, and $CuAl_2$.

Making use of the relation established by Einstein and generalised by Nernst, the specific heats may be calculated from Lindemann's formula—

$$\nu = 2{\cdot}8 \times 10^{12} \sqrt{(T/mv^{2/3})} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1),$$

which gives the atomic frequency of an element as a function of the absolute melting-point, the atomic weight m and the atomic volume v. In the case of a binary compound—

$$\nu'/\nu = \sqrt{(T'_f/T_f)} \,.\, \sqrt{(v/v')} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2),$$

where ν', T'_f and v' indicate respectively the frequency, absolute melting-point, and atomic volume of the element in combination. For metallic solid solutions, with which it is assumed that the specific volume follows the law of mixtures, this reduces to $\nu'/\nu = \sqrt{(T'_f/T_f)}$, where T'_f denotes the absolute melting-point of the alloy. In order to determine approximately the influence of the factor $\sqrt[3]{(v/v')}$ of equation (2) in the case of Cu-Al alloys, the author has measured the specific volumes of the three definite compounds. In each instance, the compound is formed with diminution in volume of the solid components, the percentage contractions being 2·9, 3·8, and 4·0 for CuAl, $CuAl_2$ and Cu_3Al respectively. The influence of the specific volume factor of equation (2) is therefore not negligible, and the molecular heat cannot be calculated merely from the melting-point. A quantitative solution of the problem is not possible, since the absolute value of the specific volume of each of the components in the alloy cannot be determined experimentally.

The heats of formation of the three compounds in kg. cals. per kg.-mol. are found to be: CuAl, + 32·38; $CuAl_2$, + 23·29; Cu_3Al, — 13·38. The most highly exothermic is, therefore, that formed with the least contraction, and there appears to be no relation between the heat of formation and the deviation from Neumann and Kopp's law. T. H. P.

1585. *Properties of Thallium-Lead Alloys.* **L. Rolla.** (N. Cimento, 9. pp. 388–395, May–June, 1915.)—The investigations of Kurnakow have shown that, in certain cases, a maximum occurs on the melting-point diagram of a binary system without corresponding singular points on the curves representing other physical properties. Thus, with Pb-Tl alloys, the fusion diagram exhibits a maximum [see Kurnakow and Puschin, Abs. 788 (1907)], and the curve of electrical conductivity is continuous and shows a minimum, but this is not in correspondence with the maximal melting-point. Similar behaviour is shown by the hardness curve, and the conclusion drawn is that Pb-Tl alloys are composed of solid solutions.

According to Bernouilli's experiments [Abs. 135, 711 (1911)], a dilute solution of two metals is thermoelectrically negative towards the metallic solvent, that is, behaves in the same way as bismuth does towards other metals. Further, as the concentration of the alloy increases, the thermoelectric force also increases, the behaviour of the solid solution towards the solvent becoming increasingly similar to that of bismuth. Since, according to Schenck's theory, $\epsilon = k \log_e (p_1/p_2)$, where ϵ is the thermoelectric force for a difference in temperature of 1 deg., k a constant, and p_1 and p_2 the pressures of the electrons in the alloy and the metallic solvent, and since also Bernouilli's results indicate that p_1 is less than p_2, it would appear that Babo's law may be extended to electronic phenomena.

Thallium-lead alloys exhibit singularity in this respect, the β-solid phase, at least until the percentage of Tl is moderately small, being thermoelectrically positive towards lead. Consequently, if these alloys are regarded as solid solutions, Babo's law is not verified, a change of sign being necessary in Schenck's formula. From the Einstein-Planck and the Nernst-Lindemann formulæ, Bernouilli has deduced the relation $\epsilon = k \log_e (T'_f/T_f)$, where T' and

$T_{\prime}$ are the absolute melting-points of the alloy and pure solvent respectively. As with Bernouilli's alloys, so in the present case, $T'_{\prime}$ is greater than T and ε consequently greater than zero.

Lewkonja [Abs. 771 (1907)] regards the Pb-Tl alloy of maximum melting-point as the definite compound $PbTl_2$, and if this has real existence, its formation from the components should be accompanied by a variation in volume. The author finds, however, that the specific volume of an alloy of this composition is in agreement with the value calculated by the law of mixtures. The same is the case with the specific heat, but here the modern theory of specific heats indicates that the difference between the observed and calculated values should be small. The heat of formation of the alloy, $Pb : Tl_2$, is 6608 gm. cals. T. H. P.

1586. *Behaviour of Vanadium and of Boron towards Silicon, Nickel, etc.* **H. Giebelhausen.** (Zeits. Anorg. Chem. 91. pp. 251–262, April 6, 1915.)—Compiled from the notes of the late author. The alloys were prepared by direct fusion of the constituents, not by reducing, *e.g.*, vanadium oxides with nickel. The thermo-couple was standardised by assuming the melting-point of Si to be 1425° (Guertler and Tammann). A vanadium of 94 % V was reduced by thermit and fused in a Hessian crucible lined with magnesia. The compound VSi_2 gives needle crystals, harder than Si, melts at 1655° and forms no solid solutions with Si; the range up to 60 % V was investigated. Nickel forms a series of solid solutions with vanadium (studied up to 86 % V); the transformation-points of Ni are lowered by the addition of V. Vanadium is not miscible at 1800° with either Cu or Ag. Amorphous boron dissolves in molten Ni, and forms the compounds Ni_2B and Ni_3B_2, melting at 1225° and 1160°, further NiB, and possibly Ni_2B_3 which forms solid solutions. The compounds are scratched by topaz; they are magnetic only in the presence of free Ni. When amorphous boron is fused and further heated in magnesia tubes up to 1600° in a current of hydrogen, together with Cu, Ag, Tl, Bi, Pb, Sn, the boron is not changed, and the other body (metal) is hardly wetted. Fused calcium fluoride and boron do not react with one another, but cadmium fluoride is violently decomposed by fused boron, cadmium being liberated. H. B.

1587. *Properties of Cold-worked Metals.* Part I. *Density of Metallic Filings.* **T. M. Lowry** and **R. G. Parker.** (Chem. Soc., J. 107. pp. 1005–1018, July, 1915.)—Contains the results of experimental work to determine the changes of density and volume produced by filing metals and then by annealing the filings at different temperatures. The results confirm the general rule that the density of the filings is less than that of the mass of metal, but in the case of Mg and Pt the density of the filings was greater than that of the mass. The results obtained are not conclusive, since the filings obtained may enclose air, especially in the case of soft metals. The complete annealing of the filings obtained is shown to be accompanied by a contraction of volume; this is ascribed to the recrystallisation of amorphous material produced by working as postulated by Beilby [Abs. 92B (1904)]. This contraction is, however, preceded by an expansion of volume that appears to be independent of the nature of the metal. In the case of certain metals, namely Au, Ag, Cu, Co, Ni, and Sb, this intermediate expansion is preceded by a preliminary contraction. In the case of gold, the preliminary contraction and the intermediate expansion can be observed to take place consecutively when the metal is heated at 100°. The process of annealing may thus involve three distinct changes, of which only the last has hitherto been described and explained. The preliminary contraction may be found to be associated with some allotropic change and the intermediate expansion with release of mechanical strain, but there is insufficient evidence to decide these points at present. C. O. B.

1588. *Comparison of the Properties of a Nickel, Carbon, and Manganese Steel before and after Heat Treatment.* **R. R. Abbott.** (Am. Soc. Mech. Eng., J. 37. pp. 440–442; Disc., 442–443, Aug., 1915. Abstract.)—A comparison has been made of the mechanical properties of three steels of the compositions shown in the table below :—

	Carbon Steel.	Nickel Steel.	Manganese Steel.
Carbon, %	0·342	0·336	0·341
Manganese, %	0·54	0·55	1·61
Nickel, %	nil	3·17	nil

Before testing, specimens of the steels were subjected to various forms of heat treatment. In the normal state, the manganese steel is slightly stronger than the nickel steel, while the toughness as measured by the reduction of area is practically the same in the two cases. In the heat-treated state practically the same results, so far as strength is concerned, can be obtained from the two steels, but the nickel steel always has the advantage from the point of view of toughness. It appears, therefore, that Mn has about three times the strengthening effect of Ni. Overheating and underheating has about the same effect on both classes of steels. In the *discussion*, **Howe** pointed out that it is common knowledge that Mn has about twice the effect of Ni in strengthening steel. The advantage of the presence of either of these two elements in steel is mainly due to the fact that they retard coalescence and coarsening, with the result that under the miscellaneous conditions arising in the treatment of steels, nickel and manganese steels always retain a finer structure than is obtained in plain carbon steels similarly treated.

F. C. A. H. L.

1589. *Fatigue of Copper Alloys.* **E. Jonson.** (Mech. Eng. 36. p. 149, Aug. 20, 1915. Paper read before the Am. Soc. for Testing Materials.)—Season-cracking in brass rods is brought about by high initial stress in the surface of the rod and also by the corrosion of the metal. All forgeable copper alloys may develop cracks of the nature of season cracks when stressed beyond the yield-point by an external load. Experiments have proved that such cracking occurs only when the metal is subjected to the combined action of tensile stress and corrosion. As a working hypothesis it was enunciated that all copper alloys contain microscopical flaws which are opened out by the action of a tensile stress exceeding the yield-point. If corrosion can now take place the flaws are opened until ultimately the sectional area is diminished so that the applied stress exceeds the ultimate stress of the material, when fracture takes place. The results of tests in which various copper alloys were subjected simultaneously to tensile stress and the action of a corrosive agent indicate that there is some relationship between the elastic limit and the stress at which cracking commences. The exact relationship has not been definitely established, but it appears that cracking is liable to start when the stress exceeds the elastic limit by about

5000 lbs. per sq. in. Prolonged stress or corrosion alone is not sufficient to set up cracking. The two actions must be simultaneous, and even then the effect is only noticed in all classes of copper alloys when the stress exceeds 20,000 lbs per sq. in. The conclusion to be drawn from this is that 20,000 lbs. per sq. in. should be regarded as the practical ultimate working stress of this group of materials. The safe working stress should therefore be some fraction of this stress, say 5000 lbs. per sq. in. F. C. A. H. L.

1590. *Theoretical Heat of Solution of* $CdSO_4, \frac{8}{3} H_2O$ *and the Weston Normal Cell.* **H. v. Steinwehr.** (Zeits. Phys. Chem. 88. pp. 229–254, July 10, 1914.) —According to Holsboer (1902) the change of sign of the theoretical heat of solution at a certain temperature would indicate a transformation-point of the hydrate which Kohnstamm and Cohen placed at 15° for $CdSO_4, \frac{8}{3} H_2O$. The author criticises Holsboer and finds that this transformation-point at 15° does not exist; if calculated from Holsboer's own data it should be at a much lower temperature. As Holsboer's observations did not fit into a formula, the author makes experiments on the differential heat of solution of cadmium sulphate and its temperature coefficient, by adding successive amounts of water to saturated solutions and determining the heat-changes in a Steinwehr-Feustel calorimeter. From these and other data he deduces that the change of sign and hence the minimum of solubility occur at $+8°$ which agrees with the observations of Mylius and Funk. Finally he recalculates the total chemical energy of the Weston normal cell; the result is in better accord with the formula of Jaeger and Wachsmuth than with the formula of Wolff. The integral heat of solution of the solid hydrate in 12·5 mols. of water, *i.e.* the number of molecules of water required to give a standard solution of $CdSO_4, \frac{8}{3}H_2O$ at 18° is given by: $CdSO_4, \frac{8}{3}H_2O + 12{\cdot}5\ H_2O = CdSO_4, 15{\cdot}17\ H_2O + 1067$ cals. The temperature coefficient of the heat of solution at 18° is $-68{\cdot}15$ cals. Two formulæ give for the total chemical energy of the Weston cell $U = 47{,}427$ and $47{,}447$ cals., and the temperature coefficient 19·45 cals./degree; while Jaeger and Wachsmuth found electrically 17·44 cals. The calometrically measured energy is not independent of the temperature (as Cohen assumed), therefore, and the temperature coefficient is not to be neglected. The e.m.f. of the Weston normal cell is 1·028675 volts at 18°. H. B.

1591. *Electrolytic Diaphragm Phenomena.* II. *Concentration Changes, Direction of Transport of Water, and the Concentration of its Hydrogen Ion.* **A. Bethe** and **T. Tropoff.** (Zeits. Phys. Chem. 89. pp. 597–637, May 4, 1915.)—Further experiments on the changes produced in the concentration of salt solutions (NaCl with or without addition of HCl, HCl . NaOH, some organic salts) in the neighbourhood of diaphragms when a current is sent through the solution. In general the ions charged in one sense combine (by adsorption or chemically) with the walls of the diaphragms, whilst the other ions remain free in the pores. The concentrations of the anions and kathions on both sides of the diaphragms are determined as are also the volume-changes in the two compartments. The direction and magnitude of the water transport depend upon the hydrogen-ion concentration of the original solution. But two classes of diaphragms have to be distinguished. In the case of collodion, wood or charcoal, the water always travels with the positive current. With all the other diaphragms examined (chromated gelatin, egg-albumin, pig's bladder, gypsum) the direction of the water transport may be positive or negative; when the concentration of the hydrogen ions exceeds a certain value, the water travels in the direction of the negative pole so that the electrolyte increases in concentration on the anode side. In more concentrated solutions of NaCl the changes (referred to the same quantity of electricity) effected in the concentration become smaller, and the isoelectric point (indifferent solutions, in which the reversal in the transport direction is observed) is shifted towards the acid side. When the density of the gelatin diaphragm is increased, the changes in resulting concentration also increase. Organic dyes (especially acid picrates, less so basic dyes) behave like electrolytes. The formulæ deduced agree well with the observations, at least for the high dilutions for which they are calculated. The results confirm the previous conclusion that ions (of one charge) are adsorbed or bound in the diaphragm; the resulting changes in the relative mobilities affect the water transport and its direction, and the degree of hydration of the ions is hence also important. The experiments were made with cells of the H type, the connecting side tubes fitting into one another at the middle, and the end of the inner tube being closed by the diaphragm; both connecting tubes were provided with several taps.

H. B.

1592. *Electrochemistry of Polonium.* **G. v. Hevesy** and **F. Paneth.** (Monatshefte d. Chemie, 36. pp. 45–49, Jan., 1915.)—In continuation of former work [see Abs. 581, 582 (1914)] the authors electrolyse polonium solutions of 10^{-8} concentration in N/10 nitric acid for 24 hours, passing a current of nitrogen gas through the bath. When the current intensity is gradually raised, the potentials rise at both the electrodes, suddenly at $E_{Hg} = 0{\cdot}85$ volt at the kathode and at 1·05 volt at the anode; some polonium is deposited at all potentials, however. Deposits are formed both of metallic polonium and peroxide (probably), on the kathode and anode respectively; the latter deposition is convenient for separating polonium from the noble metals, and by suitably changing the conditions of the electrolysis all the polonium may be sent to the anode. The decomposition potential of polonium is calculated at 0·57 volt. Neutral and weakly acid solutions are to be avoided, since polonium solutions tend to become colloidal.

H. B.

1593. *Electroplating with Cobalt.* **H. T. Kalmus, C. H. Harper,** and **W. L. Savell.** (Am. Electrochem. Soc., Trans. 27. pp. 75–117; Disc., 118–130, 1915. Engineering, 100. p. 452, Oct. 29, 1915. Abstract.)—This is a part of the research on cobalt conducted for the Canadian Dept. of Mines [see Abs. 225 (1915)]. Trying 16 types of solutions the authors find that certain cobalt baths are far preferable to nickel baths as to current density applicable, rapidity of deposition, hardness, adhesion, and durability of deposits, throwing-power (capability of giving even deposits on uneven surfaces), economy of metal, current efficiency, stability of the bath, and simplicity of operations for plating brass, iron, steel, copper, tin, lead, electrotypes, and Britannia metal. Two baths are particularly recommended, and the excellent results obtained with these are fully confirmed by W. S. Barrows, electroplater of the Russell Motor Car Co., of Toronto, after commercial trials extending over several months with parts of motors, skates, etc. The two best baths are: Solution IB, consisting of 200 gm. of $CoSO_4 . (NH_4)_2 . SO_4 . 6H_2O$ per litre of water, density 1·058 at 15° C.; solution XIIIB, consisting of 312 gm. of $CoSO_4$ and 19·6 of NaCl per litre of water to which boric acid is added nearly to saturation, final density 1·25 at 15° C. Agitation of the baths is not required. Both cast and rolled anodes of cobalt are used;

the former are more readily soluble than the latter, and their proportion is adapted to the conditions. The anode area was about twice the kathode area; the cross-section of the tank should be considerably larger than the electrode area. Solution IB is nearly saturated; no preliminary coating of copper is needed for iron and steel; the bath should be kept neutral; alkaline baths give greyish deposits apt to peel and pit; good cobalt deposits are white and take polished a slightly bluish cast; in the practical trials densities of 42 amps./sq. ft. (kathode area) were used, which is 4 times the speed of the fastest commercial nickel baths. With solution XIIIB brass automobile trimmings could be plated at 244 amps./sq. ft., in still baths; embossed brass stampings and also skates were plated in one minute instead of one hour with nickel. The mechanical tests were very satisfactory; cobalt-plated skates looked in excellent condition after one winter's wear. Full particulars are to be given in the report to the Dept. of Mines. In the *discussion,* the importance of the communication was generally emphasised. **O. P. Watts,** who had himself tried 50 cobalt baths, pointed out that the current densities stated had often been exceeded, but hardly in commercial practice; nickel baths did not keep well in long runs; the fact that the Co anodes did not turn passive was remarkable. **G. B. Hogaboom** questioned the commercial advantages of very rapid plating. **W. Blum** accentuated the importance of rapidly obtaining thick deposits in electrotyping. H. B.

1594. *Anodic Potentials of Silver.* I. *Determination of the Reaction Potentials of Silver and their Significance.* **J. H. Reedy.** (Am. J. Sci. 40. pp. 281–298, Sept., 1915.)—"Reaction potential" is defined as the p.d. which must exist between a metal and a solution for a definite action to begin; it is best measured by the third electrode method. For polarisable silver electrodes, where the products of reaction are soluble, the point of greatest curvature on the current-potential curve is taken as the reaction potential.

Using silver anodes, a large number of different electrolytes, which may be either acids or salts of a metal other than silver, show the same reaction potential, 0·521 volt, independent of the concentration. After considering and rejecting various interpretations, the author concludes that this voltage is the "solution (or ionisation) potential" of silver, that is, the potential at which silver sends ions into the solution.

Reaction potentials below 0·521 volt occur with electrolytes which give rise either to insoluble silver salts or to the formation of complex ions. These potentials, except in the neighbourhood of the solution potential of silver, are approximately logarithmic functions of the dilution in accordance with Nernst's formula, the increase in potential with the dilution being somewhat greater than would be expected from the theory. Certain electrolytes, for example a very dilute solution of potassium iodide in 0·5 m-H_2SO_4, show two reaction potentials, the lower one being due to the deposition of the anion, the other (0·521 volt) to the solution of the silver. Electrodes coated with the insoluble silver compound formed with the anion of the solution show higher deposition potentials than do electrodes of bright silver.

The presence of the kathions of other metals generally has no effect on the reaction potential of silver. With solutions of copper and mercury salts, however, silver gives abnormally high solution potentials. It is suggested that these metals may form solid solutions with silver, with a resultant lowering of its electrolytic solution pressure. T. S. P.